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Air Pollution Pilot Study: Assessment Methodology and Modeling, 1975-1979 (First Follow-Up Report)

NATO Committee on the Challenges of Modern Society, Brussels (Belgium)

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COMMITTEE ON
THE CHALLENGES OF
MODERN SOCIETY

AIR POLLUTION

PILOT STUDY ON AIR POLLUTION ASSESSMENT METHODOLOGY AND MODELING FIRST FOLLOW-UP REPORT

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Number 114

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Report is first follow-up report of Federal Republic of Germany about the recommendations made by the Air POllution Pilot Study Assessment Methodology and Modeling (1975-1978). Reports Report concentrates on recommendations of the final report which was NATO/CCMS, No. 105. Their is reference to exchange of information on application of the Air Quality Management Systems (AQMS) methods and techniques as described in the technical documents of the study.

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ASSESSMENT METHODOLOGY AND MODELING

1975 - 1979

1 st FOLLOW-UP REPORT

submitted by

the Pilot Country, Federal Republic of Germany, Fall 1980

NATO

Committee on the Challenges of Modern Society

August 31, 1980

When it comes to an evaluation of international multilateral activities in protection of our environment the work of the NATO Committee on the Challenges of Modern Society (CCMS) can be qualified as the most effective one. This efficiency is mainly due to the fact that the work is carried out in form of pilot studies which shall not run more than 3 to 4 years; this means: quick results shall be provided as long as the problem dealt with is an urgent one. The studies give recommendations for appropriate measures directed to the member governments. Member governments are required to report for a period of three or five years after completion of a study and issuing of the recommendations on the implementation of the latter. The pilot of the pilot study has to compile and assess these reports and to annually submit it in a consolidated form to the CCMS.

The present report is the first follow-up report of the Federal Republic of Germany about the recommendations made by the Air Pollution Pilot Study Assessment Methodology and Modeling (1975 - 1978).

The follow-up activities to report on concentrate on recommendations I, II, VI, VII, VIII, IX and XI (see Final Report, NATO No. 105). They refer to the exchange of information on the application of the Air Quality Management System (AQMS) methods and techniques as described in the technical documents of the study.

The follow-up activities consist of

a) annual AQMS Workshops at which the experiences of the participating NATO countries in applying the AQMS approach are discussed;

b) International Technical Meetings on Air Quality Modeling and its Application to bring together developers and users of air quality models to discuss their findings and issues of common interest.

The topics of the five workshops to be held from 1980 through 1984 cover all aspects of an AQMS and shall at the end of the follow-up reporting period provide a comprehensive view of the use member states make of the AQMS approach as described by the pilot study:

1980	Air Quality Management Systems
1981	Emission, assessment and standards
1982	Ambient air quality and deposition
1983	Emission projection and air quality simulation
1984	Strategy with respect to plans

At the 1980 workshop on Air Quality Management Systems a summary report on selected characteristics of air quality management in Belgium, Canada, the Federal Republic of Germany, the Netherlands and the United States of America was given. It was followed by a presentation of the philosophy of the national air quality management in Germany, the United Kingdom and the United States of America together with a discussion of particular problems of implementation and enforcement.

The different systems are consolidated by Herbert Meinl in the present report. It is completed by Richard Dams' summary report to which all background papers available are annexed.

I herewith should like to take the opportunity to thank all participants of the workshop, in particular the authors of discussion papers, for their active co-operation.

Christa Morawa

Chairman

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INTRODUCTION

It is common practice in NATO/CCMS work, that air pollution pilot studies are followed by a follow-up program; this was the case with the first pilot study with its follow-up program from 1974 to 1979 and also the case with the second pilot study with its follow-up program from 1980 to 1984.

The second air pollution pilot study focused on air quality management systems (AQMS) as a whole and on certain building blocks of the AQMS. Thus, the present follow-up program as outlined in the chairman's foreword is a consistent continuation of the previous pilot study. For this second follow-up activity an organizational structure was chosen which seems to be appropriate for this type of work: each of the topics

- Air Quality Management Systems
- Emission: assessment and standards
- Ambient air quality and deposition
- Emission projection and air quality simulation
- Strategy with respect to plans

is given a special workshop with presentations by member countries and with the opportunity for extensive discussions. This structure seems to be highly effective in the exchange of information as has been shown by the first workshop during April 1980 in Lindau/Federal Republic of Germany.

The topic of this first workshop was "Air Quality Management Systems" (AQMS) and thus a basis was established for the following workshops, dealing separately with different building blocks of the AQMS.

Before evaluating the results of the Lindau-workshop, some general remarks on the different approaches or strategies which can be applied to solve air pollution problems are neccessary. Each strategy is intended to reach and maintain an acceptable level of ambient air quality, and there are different possible strategies to reach this goal:

A very rational and widely used strategy translates this general goal "acceptable level of ambient air quality" into a manageable, quantitative form by defining ambient air quality standards (or objectives - depending on whether the standards are legally binding or not -) for certain pollutants. All clean air measures are adjusted to reach and maintain these standards. This strategy in its pure form is called "Air Quality Management".

Another well known strategy is based on emission standards which have to be met by each member of defined source categories, independent of ambient air quality.

Other strategies are based on economic considerations.

None of these strategies is applied in its pure form; the strategies found in actual fact combine at least two pure strategies, mainly the "ambient air quality standards"-strategy and the "emission standards"-strategy, thus making use of the advantages of both of them.

The topic of the present follow-up program and the Air Quality Management System as outlined in NATO/CCMS Doc. No. 71 (rev.) are to be understood in such a comprehensive way.

The overview given by R. Dams and the papers submitted by participating countries show a great variety in details, but they show a great harmony in applying or intending to apply the Air Quality Management approach, a harmony which has evolved during the last decade.

CHAPTER I

OVERVIEW OF AIR QUALITY MANAGEMENT SYSTEMS IN NATO MEMBER COUNTRIES

by Richard DAMS

Nine member nations were requested to send an overview of the AQMS in their country. Six, namely Canada, United States, United Kingdom, Federal Republic of Germany, Netherlands and Belgium sent a short summary. In this paper an overview is given of the highlights of these six summaries. As explained in the revised document no 71 on AQMS, such a system consists of a number of blocks or elements. In table 1 it is shown which elements have been discussed in nearly all reports and which elements were only sparsely or not at all mentioned. These topics will now point by point be overviewed for the six countries. This summary is obviously incomplete. For more complete information the reader is referred to the original more extensive papers of the United Kingdom, United States and Federal Republic of Germany and to the summaries in the annex to this publication.

Philosophy and major principles of the AQMS

First the major principles and philosophy on which the AQMS is based are overviewed.

In Canada it is based on a shared jurisdiction and responsibility between the federal government and 10 provinces. The setting of detailed ambient air quality standards and the establishment of emission and product standards form the basis for the Federal Government's air pollution control activities. The government philosophy on pollution control is based on containment at source, but also recognizes that local conditions may require more stringent control.

In the USA the heart of the air quality management is the set of ambient air quality standards. The federal government, through EPA, provides the leadership and financial assistance, but leaves it to the States to try to meet these standards in a reasonably timely and effective manner. EPA also provides research, funds and guidelines to the States. The general guiding principle in the USA is that emission shall be controlled at the source.

The United Kingdom approach to Air Quality Management System has been pragmatic and flexible. In accordance with this overall philosophy no national air quality standards or guidelines have yet been laid down by the central government. The air pollution control in the UK has been focussed on two main areas, emission controls and stack height considerations, both of which are operated within the overall framework of practicability. One of the principles followed by the successive governments has been that the primary responsibility for dealing with pollution problems should rest as far as practicable with authorities operating at a local or regional level. Great-Britain further adheres to the principle that the "polluter pays".

In Germany the environmental protection policy of the government in AQM is based on 3 major principles, called

1) Precaution: requires to preserve the environment as much as possible; Generally, by using the best available control technology for emission reduction in installation and operation of plants.

2) Polluter-Pays-Principle: the polluter is responsible for the costs of avoiding, eliminating or compensating the damage done to the environment.

3) Cooperation between federation, Länder, local authorities and citizens. Standards are set and also means for control (measurements) are standardized while enforcement is a task of the Länder.

In the Netherlands the approach is rather on an individual basis. For any industrial or trading activity that might yield damage or nuisance to the environment a permission is required from local, provincial or governmental authorities. This is true even for very small firms. The rule of best practical means is used as guideline for the requirements to restrict air pollution, laid down in the permission to operate the plant. An SO_2-Air Quality System (SO_2-beleidskaderplan) has been set up, and includes objectives for the ambient air quality and a plan for a control strategy with emission standards for the future. The implementation of this plan is expected for 1981.

In Belgium the situation is very similar to the one in the Netherlands. The AQMS is primarely based on licensing on an individual basis. Several elements of the AQMS, such as the emission inventory and the modelling are still carried out within the framework of a national research and development programme. A very general outline law attributes large competences to the executive authorities to formulate emission, equipment and product standards.

Legal basis of the AQMS and Responsibilities

Nearly all nations have a type of Clean Air Act which lays down the basis for an AQMS.

In Canada a Clean Air Act was officially proclaimed in 1971 and has 3 main elements that define the responsibilities.

1) In the first the primary jurisdictional authority of the provincial governments is recognized by the federal government.

2) In its second element the Act defines the areas where federal jurisdiction is involved (hazardous pollutants, emissions from the federal facilities, composition of fuels).

3) Thirdly the federal leadership enables to promote uniformity across Canada.
Cooperation is ensured by a Federal Provincial Committee, because the jurisdiction is a shared responsibility.

In the USA the relationships between Federal, State and local governments have been established by the Clean Air Act enacted in 1963 and since amended several times, most recently in 1977. The EPA is the federal body responsible for administering the Clean Air Act. EPA sets ambient air quality standards and the States must set up implementation plans, by means of emission limitations, monitoring programs etc. Thus the States have the final responsibilities for the control of air pollution. However, EPA also sets emission standards for selected categories of new sources and provides guidelines for control strategies, including the fields of air quality modelling, monitoring procedures, emission control procedures etc. Numerous court decisions have been useful in interpreting the meaning of the Clean Air Act.

In the United Kingdom the legal basis dates back from 1863 when the Alkali Act was issued, to control the emission of noxious gases from alkali works. Britain has generally built up her law and administration stage by stage in response to particular problems. As a result the law relating to air pollution is to be found in a number of statutes. The most important example of the control exercised by the local authorities is the 1956 Clean Air Act which empowers local authorities to give smoke control orders. The subsequent Clean Air Act of 1968 and the Control of Pollution Act in 1974 extended the powers of local authorities. At central government level most pollution problems are dealt with by the Department of the Environment. Other Departments are however involved. The Secretary of state for the Environment has the general responsibility of co-ordinating the work of the Government on environmental pollution and in this

he is assisted by directorates within the Department of the Environment. The central government lays down the statutory framework for pollution control, but implementation is delegated (Emissions Inventory Syst.) to a large extent to local level.

In the Federal Repbulic of Germany the legal basis for the AQMS is laid down in the Bundesimmissionsschutzgesetz (BImSchG) as of 1974 with pertinent legislative orders such as the Technische Anleitung zur Reinhaltung der Luft (TA Luft-Technical Instructions for Air Pollution Control). The responsibilities are with the Federal Minister of the Interior, within which the Umweltbundesamt (Federal Environmental Agency) was established in 1974 for assistance and scientific advice. The preparation of legislative provisions is assisted by the Kommission Reinhaltung der Luft (Commission on Air Quality) of the Association of German Engineers. Together with the Deutsches Institut für Normung (the German Standards Institute) it works out technical guidelines for the control of air quality, which quite often are referred to in the pertinent legislation.

In the Netherlands, at the end of the previous century a nuisance law came into force. The intention was to control any nuisance, danger or damage, not only from air pollution but also from all other types of nuisance. This law had obviously severe shortcomings. It was therefore in 1968 supplemented with an Air Pollution Law. Both laws stipulate primarily that all industrial and trading activities are subject to a permission in order to start, alter or expand their operation. Even very small firms must obtain this permission from municipal authorities as laid down in the nuisance law. For operating larger facilities, in addition a permission, that is a license, must be obtained according to the Air Pollution Law. Execution of this latter is in the hands of the 11 provinces, by means of the Executive Committee of the Province.

This Air Pollution Law gives the central government also the possibility for setting more general rules such as emission, equipment or product standards. The Governor of the province can also take measures in case of severe air pollution, say a period of smog. In 1971 an Inspectorate for Environmental Hygiene was set up. This is closely related to the Ministry of Public Health and Environmental Hygiene. Requests and permissions according to the nuisance law and the Law on Air Pollution must be sent to this inspectorate for advice.

In Belgium again the situation is very similar to the one in the Netherlands. Already in 1791 a kind of nuisance law was introduced and, in 1946, approved in its actual form. The real start of the legislation was an outline law passed in 1964. The latter allows the Ministry of Public Health in cooperation with the Minister to the competence of whom the origin of the pollution problem belongs to issue royal decrees in the field of air pollution. These royal decrees can impose regulations and restrictions on equipment, products or emissions. Since 1971 five such decrees have been issued.

While for individual licensing there is a shared responsibility, the execution of the royal decrees is always with the central government.

1. EMISSIONS INVENTORY SYSTEMS

All nations have in some way at least an incomplete emissions inventory system. In Canada in 1972 a nationwide emissions inventory was compiled. It was one of the first actions taken by the Federal Government after passage of the Clean Air Act. It provided an overview for the 1970 emissions and was revised for

1972, 1974 and 1976. The compilation of the data is mostly based on questionnaires and on calculations using emission factors. The data handling was in 1974 changed from manual to computerized. It is regulary updated. It is special since it contains two types of inventories. First, it gives a national overview for four major contaminants (particulate matter, SO_2, CO, NO_x) and includes hydrocarbons as well. Secondly, there are complete data for 17 hazardous air contaminants and for at least 12 other an inventory is in preparation. The responsibility for gathering the data lies with the Air Pollution Control Directorate.

In the USA the National Emission Data System (NEDS) is a computer based data handling system for six criteria pollutants. It is annualy updated and divided in point sources, that is with emissions more than 1000 tons/year, and in area sources, which are collected by a collective approach. The responsibility for collecting the data is with the federal institution, the states, the counties and the local authorities while EPA alone is responsible for the system, that is the data handling.

In the United Kingdom, total emissions of various pollutants (SO_2, particulates, NO_x, CO, hydrocarbons, lead, etc.) are calculated annually. Inventories relating to smaller areas are not compiled as a matter of routine, but two detailed studies, in Central Scotland and London, have resulted in detailed inventories being produced for these areas.

In Germany a high resolution emissions inventory was initiated in 1974 for the Cologne area. It was first completed for Nordrhine-Westphalia. But meanwhile emission inventories have been established or at least started in a number of other areas which have been declared by the federal authorities as heavily polluted areas, for which a clean air plan has to be established. The data collection is based on individual approaches, such as mea-

surements and questionnaires for industrial sources, and a collective approach for the other source types. For all inventories emission declarations will be required. All pollutants are included and updating is achieved by means of emission records kept by the operator or owner of the plants. The responsibility is with the Länder.

In the Netherlands a high resolution emission inventory system was first initiated in 1974 and continued in a sequence province by province. It will be completed in 1980. Revision and updating should start in 1981. All possible pollutants are included. The computerized system includes also an inventory of the water polluting emissions. The system is similar to the German one. The responsibility is with the Central Government.

In Belgium within the framework of a research and development programme, a methodological study of emission inventory systems was started in 1975, and applied to three test-areas. A high resolution (1 km^2 grids) system, modified after the German and the Netherlands systems was applied. Data pertaining to 1977 - 1978 and 1979 are being completed in 1980, primarily for SO_2 but also for the other criteria pollutants and, if possible and important, for all other pollutants. In 1978 a start is made to expand it to the rest of the country on a province by province basis. Annual updating is foreseen. The responsibility for the data collection and the computerized data handling lies with the Ministry of Science Policy, but is performed in collaboration with universities or state laboratories.

2. AMBIENT AIR QUALITY STANDARDS AND MONITORING

While in all countries some monitoring of the ambient air quality is performed, ambient air quality standards do not exist in all countries.

In Canada air quality objectives are prescribed for desirable, acceptable and tolerable ranges for seven pollutants, namely TSP, SO_2, CO, oxidants, NO_2, HF and H_2S. The maximum levels are defined as follows and set by the Clean Air Act: Desirable means setting long-term goals - it provides a basis for the anti-degradation policy in less polluted parts of the country.

The acceptable maximum levels provide a protection against effects on soil, water, vegetation, materials, animals, insulation, well-being, etc.

The tolerable levels require when exceeded abatement without delay to avoid further deterioration. These levels pose a threat to public health.

Monitoring is performed by the National Air Pollution Surveillance Network. The following components are monitored: TSP, SO_2, CO, NO_2, oxidants, HC, Pb, dust-fall, sulfatation rate and meteorological parameters. There are 158 stations. The network is operated by provincial agencies, and sometimes by the federal government. The federal government also supplies technical advice on instrumentation maintenance and calibration. The data must be reported to the federal government.

In the USA, the federal body, the EPA, establishes national ambient air quality standards. This approach is dictated by the Clean Air Act. A state may establish more stringent ambient air quality standards. The primary and secondary standards for TSP, CO, SO_2, ozone, nitrogen oxides and HC are well known. Recently some have been revised and one for Pb has been added.

The secondary standards are also intended to ensure the well-being, and, as such, are comparable to the maximum acceptable levels of Canada. The primary standards are intended to maintain public health and are thus comparable to the tolerable levels in Canada. Monitoring is performed by the National Air Monitoring Stations (NAMS). The stations are mostly automated, but some manual stations exist (in total ± 4000 sites) too. The data provide nationwide information on trends in air quality.

In the United Kingdom only one local authority has published suggested guidelines for ambient concentrations of some pollutants. The Royal Commission on Environmental Pollution proposed the establishment of air quality guidelines for a number of atmospheric pollutants. The EEC Health Protection Standards Directive sets maximum permitted concentrations for smoke and SO_2 on an annual, winter and daily basis.

Monitoring of smoke and SO_2 has been performed for many years in the United Kingdom at 1200 stations. Other monitoring programmes are also carried out involving the measurement of NO_x, hydrocarbons, ozone and CO as well as heavy metals, sulphates and nitrate amongst others. To ensure that all the monitoring programmes produce useful information the Government issued a report in 1974 on "The monitoring of the Environment in the United Kingdom" and has set up a series of sectorial monitoring management groups. The formation of these groups is a first step towards the development of a comprehensive, flexible and unified monitoring system.

In the German "Technische Anleitung zur Reinhaltung der Luft" a large number of air quality standards have been set. These are divided in IW 1 for long-term exposure (annual mean) and IW 2 for short-term exposure (95 percentile of half-hourly values). They exist for dust concentration (all particles and

those smaller than 10 µm), for dust-fall and for the gases Cl_2, HCl, HF, CO, SO_2, H_2S, NO_2, NO and since 1978 also for Pb and Cd concentrations in the air and in dust fall. Also since 1978 some additional air quality threshold values for the protection of animals and vegetation have been formulated. Air quality monitoring is performed for criteria pollutants by national and regional authorities in most large cities and in heavily polluted areas. Mobile stations are being used too.

In the Netherlands no air quality standards have yet been enacted. But recently objectives for 50, 95 and 98 percentile SO_2 concentrations have been formulated and will serve as a basis for standards that will be set in the near future. The objectives include also an emergency SO_2 level.

The ambient air quality is measured by an autonomous National Air Pollution Network that includes SO_2, NO_x, oxidants and, at some sites, CO, HC and TSP as well. Also chemical analysis of rainfall in a 12 station network is performed. Heavy metals are determined routinely by some networks.

In Belgium too general air quality standards have not been set. There are however a few local exceptions. For the immediate vicinity of power plants and around one single non-ferrous plant and one single enamel plant standards for respectively SO_2, Pb and F^- were established.

An autonomous network with 31 stations for SO_2 and sometimes NO_2, NO, CO, TSP and HC was established in the five major cities and along some of the borders. In addition to that a manual network with 230 stations exists, which since 1967 measures acidity and smoke. Since 1966 some local networks for fall-out exist. A heavy metal network with 15 stations runs since 1972. The earlier mentioned Standards around the two earlier mentioned plants are of course also surveyed.

3. EMISSION, EQUIPMENT OR PRODUCT STANDARDS - LICENSING

In all nations some type of emissions standards exist; although sometimes on an individual basis, they have mostly been formulated for a certain sector. Product or equipment standards have generally been formulated for the S-content of fuels, the Pb-content of gasoline, the emissions from mobile sources.

In Canada the Federal Department of the Environment has a program of developing Emission Guidelines for specific industry sectors. These are not enforceable but are federal requirements for new sources, and are goals for existing sources. Local conditions may require more stringent control. Such sectors are cement, asphalt, coke production, incinerators, woodpulping, etc. For a number of other sectors such as iron and steel, ferrous foundries, petroleum refineries, thermal power plants, etc. guidelines are presently being developed.

On the other hand National Emissions Regulations are enfo able by the Federal Government. Examples are Pb, Hg, asbestos, vinylchloride, etc., because these pollutants consitute a significant danger to human health. For mobile sources emission limits exist for CO, HC and NO_x since 1975.

As product standards the Pb-content for lead-free gasoline and for leaded gasoline have been reported. Also fuels information regulations exist. In fact every person who produces or imports at least 400 m^3 fuel must report the information. As in most urban centres, also in some Canadian cities the S-content of fuels is restricted.

In the USA the formulation of emission limitations and their enforcement are the responsibilities of the States according to the Clean Air Act. The air quality management takes place through the regulation of the amount, location and time of

pollutant emissions. The practice of this air quality management is a methodology implying an air quality simulation model, which allows to deduce from the ambient air quality standards the required emission product or equipment standards. Although the States have the final responsibilities, EPA identifies feasible control procedures for existing sources and develops source emission performance standards for new sources in many categories of industrial activities. National emission standards have been set for 25 - 30 source-types.

Exceptions to this general philosophy are again the emission controls for mobile sources which are legislated by the Congress and enacted into law.

In the United Kingdom, apart from a few national standards, most of which relate to products, there is no legislation in emissions. Authorities both central and local are expected to operate on the philosophy that standards should be reasonably practicable. This pragmatic approach permits the establishment of individual standards for polluting emissions from particular factories which can be made continually more stringent and thus allow for a greater flexibility than statutory standards. The acts of 1956 and 1968 empower local authorities to issue smoke control orders prohibiting the emission of smoke. The Secretary of State may specify in regulations particular fuels or classes of fireplaces as being smokeless. The act of 1974 gave the Secretary of State the power to limit the S-content of oil fuel for furnaces or engines. The Motor Vehicles Regulations of 1973 controlled the emissions from mobile sources (smoke, hydrocarbons, CO). The Pb-content of gasoline has been reduced down to 0.45 g/l, and in January 1981 will be reduced to 0.40 g/l.

In Germany according to the principle of precaution emissions must be controlled in a way that the application of all possible emission reduction measures, taking into account the best available control technology, is assured.

Plant related measures are taken because industrial and trade facilities may not operate without a license. Based on the BImSchG, about 100 groups of plants are subject to licensing. Emission standards are given for 170 air pollutants and for more than 40 plant-types in the TA Luft*. Also the procedures to be used for measurement and assessment as well as for dispersion modelling of emission are laid down in this law. For other plants and for mobile sources additional requirements can be set.

Some product related measures have been taken. The BImSchG and other laws define relevant regulations for the manufacturers of products such as gasoline (Pb: 0.15 g/l) and other fuels (S: 0.3 %).

For offences a difference is made between illegal and criminal acts. For illegal acts financial penalties are administered by the Länder. Criminal offences are regulated by the penal code.

As said before in the Netherlands the Nuisance and the Air Pollution laws stipulate that all firms, even very small, such as bakeries, laundries, snack-bars etc. are subject to a permission from the municipal or governmental authorities. Nearly 400.000 require a permission. As a guideline for the requirements laid down in the permission the rule of best practical means is used. A handbook of what level of emission can be expected using this rule of best practical means is in preparation. A special decree, enacted in 1974, limits the sulphur content of fuels. In the control strategy plan for SO_2 the central objective is an emission ceiling (500 x 10^6 kg SO_2 for the whole country). The plan proposes some additional emis-

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* Since 1980 emission standards for certain cancerous substances have been formulated.

sion standards, equipment standards, that is instructions for design and operating standards, and product standards that should protect the environment as a whole. Even an outline of the economic consequences of the management proposals is given. As a start the control strategy plan will be implemented for a three year period.

Finally, in Belgium all firms, even very small ones, require licensing for operation. These licenses are renewable and revisable when expiring or when an alternation or expansion is requested. This is again the individual spproach.

On a more general basis some emission standards have been set by means of the five Royal Decrees, for example in 1975 for thermal power plants and large combustion facilities. These are regulations on the ash and S-content of the fuels, coupled to a minimum stack height in order to provide sufficient dispersion. Also the siting of the plant is taken into account, since in 1971 already a number of regions of special interest have been defined. Finally the S-content of all fuels used in the country has been regulated. For mobile sources the standards are very limited. The responsibilities for establishing and for enforcement rests always with the central government, but the provincial or municipal authorities can set more stringent rules. As in the Netherlands these authorities can take measures when limits are exceeded, including stopping operation.

4. SOME OTHER ELEMENTS

Other elements of an AQMS were in the reports not or only very sparsely mentioned:

- Land Use Planning:

  The incorporation of air pollution aspects in town and regional planning processes was only explicitely mentioned by Germany. In heavily polluted areas authorization for the declaration of protected areas can be obtained.

- Modelling:

  In the USA, the EPA issues guidelines on air quality modelling, which attempt to reflect the state of the art in the matter. Germany has prescribed the calculation of the dispersion of the emissions in the TA Luft, and in Belgium it is included in the law on power plants and combustion facilities. Furthermore, special attention is paid to the validation of models, again within the above mentioned research and development programme. In the Netherlands in the Control Strategy Plan for SO_2 an air quality model for the whole country has been used to estimate the impact of the projected increase in SO_2-emissions in the future.

- Projection:

  Although this is a vital element of a AQMS information on projection of future emissions was only given by the Netherlands.

- Economics:

  The economic aspects were generally overlooked in the reports, I reviewed; again, the Netherlands only mentioned it.

- Interaction:

  Interaction with other environmental media was not discussed.

- Results:

Canada describes the results of the AQMS as they are reflected sofar in a reduction of the ambient air concentrations for the criteria pollutants, the exception being NO_2, whose concentration increased considerably. United Kingdom proudly describes the decrease in ambient smoke concentrations in all urban areas of the UK, to the extent that the smogs of the 1950's and early 1960's are now non-existent, with a correspondingly significant decrease in urban SO_2 concentrations.

TABLE 1: ELEMENTS OF AN AIR QUALITY MANAGEMENT SYSTEM

Discussed		Not discussed
Major principles		Regional planning (Germany only)
Legal basis (enforcement)		Modelling (USA, Belgium, Germany, Netherlands)
Responsibilities		Projection of Emissions (Netherlands only)
Emission Inventory Systems		Economic Aspects (Netherlands only)
Ambient Air Quality Standards		Interaction with other environmental media
Ambient Air Quality Monitoring		Results (Canada, United Kingdom only)
Standards	emission	
	equipment	
	product	
Licensing		

TABLE 2: PHILOSOPHY AND MAJOR PRINCIPLES OF THE AQMS

Nation	Major Principles of an AQMS
Canada	Shared jurisdiction (Fed. + Gov.) Ambient + Emission Standards
United States of America	Federal: Ambient Air Quality Standards Emission standards for new sources States : Emission limitations for existing sources
United Kingdom	Pragmatic-Flexible-Practicability Responsibility with the local authorities Emission control - Stack height
Federal Republic of Germany	Precaution : Best Available Technology Polluter - Pays - Principle Cooperation: Fed. + Länder + Local + Citizen Ambient and Emission Standards; Stack height
Netherlands, Belgium	Licensing - Individual Local + Province + Central Gov. Emission Guidelines

TABLE 3: LEGAL BASIS AND RESPONSIBILITY FOR THE AQMS

Nation	Laws	Responsibilities
Canada	1971 Clean Air Act	FED : Department of the Environment
		PROV: Directorate of Environmental Protection
United States of America	1963 Clean Air Act amended several times (1977)	FED : Environmental Protection Agency (EPA)
	Implementation	States + Counties + Local
United Kingdom	1863 Alkali Act	Department of the Environment (Directorates)
	1956 Clean Air Act	Secret. of State of the Environment
	1968 Clean Air Act	Alkali Inspectorate
	1974 Control of Pollution Act	Local Authorities
Federal Republic of Germany	1974 Bundesimmissionsschutzgesetz (BImSchG)	FED : Minister of the Interior Umweltbundesamt
	1974 Technische Anleitung zur Reinhaltung der Luft (TA Luft)	States: relev. ministries
Netherlands	± 1890 Nuisance Law	Municipal
	1968 Air Pollution Law	Executive Committee of the Province Inspectorate for Environm. Hyg. (Min. of Public Health and Environm. Hyg.)
Belgium	1791 (1946) Nuisance Law	Municipal
	1964 Outline Law on Air Pollution, Royal Decrees	Min. of Public Health and Environment

TABLE 4: EMISSION INVENTORY SYSTEMS

Nation	Start	Resolution	Size	Pollutants
Canada	1972	low	Nationwide	Criteria Hazardous
United States of America	1972	high	Nationwide	Criteria Hazardous
United Kingdom	1950	low	Nationwide	SO_2, particulates
	1970	low	Nationwide	NO_x, CO, Hydrocarbons, Lead
	1974	high	Central Scotland	SO_2, Particulates
	1975	high	Greater London	SO_2
Federal Republic of Germany	1974	high	Heavily polluted areas	"All"
Netherlands	1974	high	Province by province	"All"
Belgium	(1975)	high	3 Test areas + provinces	SO_2 + Other

TABLE 5: AMBIENT AIR QUALITY STANDARDS AND MONITORING

Nation	Standards		Monitoring
	Type	Pollutant	
Canada	Objectives:		
	desirable	SO_2, TSP, CO	SO_2, TSP, NO_2, CO, Ox
	acceptable	Ox, NO_2	Pb, dust-fall
	tolerable	Hf, H_2S	sulphate, soiling
United States of America	Secondary	SO_2, TSP, CO	SO_2, TSP, NO_2, CO, HC, Ox
	Primary	NO_x, HC, Ox, Pb	soiling, metals
United Kingdom			Smoke, SO_2, NO, NO_2, CO, Hydrocarbons, O_3, metals, sulphate, nitrate
Federal Republic of Germany	IW 1	SO_2, NO_2, NO, CO	SO_2, TSP, CO, HC, NO_2
		Cl_2, HCl, HF, H_2S	NO, ...
	IW 2	dust (< 10 µm)	
	Threshold value	Pb, Cd	
Netherlands			SO_2, CO, HC, NO_2, NO
	Objectives 1981	SO_2	Ox, ...
			metals
Belgium	Locally	SO_2, (Pb, F^-)	SO_2, TSP, NO_2, NO, Ox, HC
	-	-	metals, smoke, dust-fall (Pb, F^-)

TABLE 6: EMISSION - EQUIPMENT - PRODUCT - STANDARDS/ LICENSING

Nation	Types of Standards	Sector	Responsibility
Canada	Emission guidelines	Industr.	Federal
	Emission regulations	Industr.	Federal
	Emission limits	Mobile	Federal
	Product standards	Fuels	Federal
United States of America	Emission limitations	Industr.	States
	Emission + standards for new sources	Mobile/ industr.	Federal
United Kingdom	Emission - individual (Flexible)	Industr.	Local + Alkali Inpectorate
	Emission	Mobile	Secret. of State
	Product	Fuels	Secret. of State
Federal Republic of Germany	Licensing + emission + equipment (best available technol.)	Industr.	Federal (Coop. Länder)
	Product standards	Fuels	Federal
Netherlands	Licensing + emission + equipment (best practical means)	Industr. (all)	Central gov. + municipal
	Product standards	Fuels	Central gov.
Belgium	Licensing + emission + equipment	Industr. (all)	Central gov. + municipal
	Product + dispersion	Fuels	Central gov.

CHAPTER II

PHILOSOPHY OF THREE EXISTING NATIONAL AIR QUALITY MANAGEMENT SYSTEMS

THE UK APPROACH TO AIR QUALITY MANAGEMENT SYSTEMS

Martin L. Williams

1. INTRODUCTION

The UK approach to Air Quality Management Systems has been pragmatic and flexible. In accordance with this overall philosophy no air quality standards or guidelines have as yet been laid down by central Government, although one local authority (Greater London Council) has published suggested guidelines for ambient concentrations of some pollutants.

Up to the present, air pollution control in the UK has been focussed on two main areas, emission controls and chimney height considerations both of which are operated within the overall framework of practicability and this is discussed in some detail below.

Although no standards for air quality exist at present, a situation which will change in the future with EEC* based legislation, ambient concentrations of pollutants, particularly smoke and SO_2 have been monitored over the major part of the UK for the past twenty years. The results from such studies are taken into consideration in the overall strategy of control as discussed below.

The following discussion therefore highlights the areas of responsibility of both central and local Government for air pollution control and discusses the structure and, briefly, the legal basis of the system. Finally, some comments on the incorporation of EEC legislation into the UK system will be given.

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* European Economic Commission

2. RESPONSIBILITIES AND PHILOSOPHY

Great Britain has a long history of concern about the protection of the environment, dating back to the reforms of the great Victorian administrators, whose awareness of the need to protect public health saw the creation of such legislation as the first Alkali Act of 1863, controlling the emission of noxious gases from alkali works, and the 1848 Public Health Act which led to improvements in the water and sewerage services. The machinery of pollution control has developed over the years in response to new environmental hazards and to increased scientific awareness of their implications, and because of public and government concern at the potential effects on human health of various pollutants.

At central Government level most pollution problems are dealt with by the Department of the Environment (DoE) in conjunction as appropriate with the Scottish and Welsh Offices. DoE is concerned with air and fresh-water pollution, noise pollution other than from aircraft, the disposal of solid and radioactive wastes, and oil and chemicals on beaches in England and Wales. Other Departments are, however, involved. The control of marine pollution by oil and pollution (including noise and emissions) from civil aviation activities lies with the Department of Trade (DT); and the Ministry of Agriculture, Fisheries and Food (MAFF) in England and Wales and the Department of Agriculture and Fisheries for Scotland (DAFS) have responsibility through the Pesticides Safety Precautions Scheme for the safe use of agricultural pesticides. MAFF and DAFS also seek to protect our fisheries, both freshwater and at sea, and in relation to this control marine pollution and dumping at sea. The Health and Safety Commission has certain responsibilities for pollution control as part of its general purpose of securing the health

and safety of persons both at work or affected by work activities, and of controlling certain emissions into the atmosphere. The Department of Health and Social Security (DHSS) and the Scottish Home and Health Department (SHHD) provide advice for other Government Departments on the health hazards posed by pollutants.

Since several Government Departments are involved in the development of policies for the control of pollutants, co-ordination is needed between sectors to ensure that control exercised in one sphere does not act to the detriment of another part of the environment and that an overall view is taken of priorities. The Secretary of State for the Environment has the general responsibility of co-ordinating the work of the Government on environmental pollution and in this he is assisted by directorates within DoE which are required to conduct across-the-board appraisals of pollution problems; to provide the central management capability for an overall monitoring and assessment system for the United Kingdom, including co-ordination of the work of the monitoring management groups to maintain contact with various specialist groups within and outside Government that are concerned with pollution; to ensure as far as possible that potential problems are not overlooked, and to see that the United Kingdom contributions to European and International Environment protection programmes are properly organized. The Secretaries of State for Wales, Scotland and Northern Ireland are responsible for overall pollution control co-ordination in their respective countries.

Since air pollution issues are often of concern only on a local, rather than national scale, one of the principles followed by successive Governments has been that the primary responsibility for dealing with pollution problems should rest as far as is practicable with authorities operating at a local or regio-

nal level, principally local authorities and the water authorities. Thus central Government lays down the statutory framework for pollution control, but implementation is delegated to a large extent to local level. Authorities may in many areas exercise a considerable degree of discretion as to the limit they impose on the release of local pollutants, so that account may be taken of local resources and social priorities, the uses to which surrounding areas are put and the capacity of the environment to absorb pollutants.

Apart from national standards, most of which relate to products, there is no general equivalent in United Kingdom legislation to the detailed and uniform environmental standards, either for particular emissions or for general environmental quality, enshrined in the legislation of many other industrial countries. Authorities, both central and local, are expected to operate on the philosophy that standards should be reasonably practicable (in the case of the Alkali Inspectorate and HM Industrial Pollution Inspectorate the best practicable), this system will be discussed in more detail below.

Great Britain also adheres to the principle that the "polluter pays", i.e. that the person or organization creating the pollution should be financially responsible for controlling it. No specific grants are given towards pollution control equipment, although it may qualify in the same way as other investment for more general financial support through the grants given for new equipment in Development Areas.

The effectiveness of preventive planning of liaison between authorities and of subsequent control measures must depend very largely on the quality of the information about local problems, about pollution trends and the way they are monitored and assessed and about possible solutions which authorities have available to them. Thus an effective monitoring and assessment system is fundamental to any pollution control

policy. Information is needed on existing pollutant concentrations, long-term trends and the significance of new emissions in order to assess where hazards lie and where to concentrate resources.

The Government issued a report in 1974 on "The Monitoring of the Environment in the United Kingdom" and has set up a series of sectoral monitoring management groups for air, freshwater, marine water and land, to ensure that all the monitoring programmes are designed to produce useful information on existing pollution levels and long-term trends in a form that can readily be used at all policy levels. In addition, two cross-sectoral management groups have been formed to build a medical and biological dimension into the monitoring and assessment system so that the health and ecological risks associated with particular levels, concentrations or combinations of existing or new pollutants can be assessed. The formation of these groups is a first step towards the development of a comprehensive, flexible and unified monitoring system.

3. ADMINISTRATIVE ARRANGEMENTS

The development of air pollution control in Great Britain has been essentially pragmatic. As an early industrial coutry Britain has generally built up her law and administration stage by stage in response to particular problems. As a result, the law relating to air pollution is to be found in a number of statutes, while the administrative arrangements are a blend of central direction and local discretion, based on the principle of "best practicable means".

3.1 Stationary Sources

Certain processes which give rise to particular noxious or offensive emissions or are technically difficult to control are regulated in England and Wales by the Health and Safety Executive through HM Alkali and Clean Air Inspectorate. The processes currently controlled in this way number roughly 60 and include chemical processes, metal manufacture, cement and brick works and the generation of electricity by the combustion of fossil fuel etc. In accordance with the pragmatic approach to such problems adopted by the UK, the legislation under which HMACAI operate in the control of emissions embodies the use of "best practicable means". This philosophy involves the use and maintenance of equipment and the operation and supervision of processes in such a way as to ensure that any discharges, effluents or wastes are controlled as far as is practicable, having regard among other things to local conditions and circumstances, to the current state of scientific and technical knowledge and medical knowledge of the potential harm or nuisance involved, and to the financial implications. This pragmatic approach permits the establishment of individual standards for polluting emissions from particular factories which can be made continually more stringent in the light of technical advance and of changing environmental needs, but allows greater flexibility than statutory standards. While the Alkali Inspectorate has responsibility for supervising the control of emissions from the processes listed above, most other forms of air pollutant emissions come under the control of local authorities, advised by central Government and the Alkali Inspectorate. The local authorities control domestic emissions and emissions from commercial and industrial processes not within the scope of the Alkali Inspectorate.

Perhaps the most important example of the control excemised by the local authorities is the 1956 Clean Air Act which empowers local authorities to make smoke control orders prohibiting the emission of smoke from buildings, including dwellings, in any part of their districts.

This Act and the subsequent Clean Air Act 1968 arose from the report of the Beaver Committee which was set up in the aftermath of the London smog of 1952, and the years since they were passed have seen a very significant decrease in ambient smoke concentrations in all urban areas of the UK, to the extent that the smogs of the 1950's and early 1960's are now non-existent. Since 1961 the average annual smoke concentration in urban areas has declined by over two-thirds with a corresponding decrease of SO_2 of roughly fifty per cent.

These two Acts stated that dark smoke may not be emitted from any trade or industrial premises or from the chimney of any building or from any railway engine or from any vessel in inland or estuarial waters or in port. The Secretary of State may by order relax these provisions and orders have been made to accommodate essential lighting up, soot blowing etc. and to exempt (subject to conditions) certain activities where dark smoke is unavoidable.

Section 11 of the 1956 Act empowers local authorities to make smoke control orders, prohibiting the emission of smoke from buildings, including dwellings, in any part of their districts. Specific buildings or fireplaces (which term includes any furnace, grate or stove) may be exempted in the order. Before the order comes into force it must be advertised and the Secretary of State must, if objections are made and not withdrawn, arrange for a local inquiry or hearing to be held. The Secretary of State may in regulations specify particular fuels or classes of fireplaces as being smokeless. A householder who as a result

of a smoke control order has to change his means of cooking or heating may claim from the local authority a grant of 70 % of the reasonable cost of installing suitable domestic smokeless appliances. The local authority may pay more than 70 % if it wishes. The Secretary of State may (and normally does) reimburse the local authority four-sevenths of its grant. Well over one-third of the premises in England and Wales, including over 90 % of those in Greater London, are reckoned now to be covered by orders. There are substantial variations between areas.

The later Control of Pollution Act 1974 and in particular Part IV of this Act, implemented in England and Wales in January 1976, extended the powers of local authorities by enabling them to obtain information about the emissions to the atmosphere from any premises other than private dwellings. The local authority may make arrangements with the occupier of the premises for either the occupier or the authority to carry out measurements but the local authority may also require the occupier by notice to supply certain information. The kinds of information which may be demanded have been prescribed in regulations made by the Secretary of State. The occupier may appeal to the Secretary of State against a notice on the grounds that disclosure of the information would prejudice a trade secret or be contrary to the public interest or that the information could not be provided except at undue expense. Any information obtained by the local authority has (with certain exceptions) to be kept in a register open to the public. Section 76 of the Act gives the Secretary of State new powers to limit or reduce air pollution by making regulations to control the sulphur content of oil fuel for furnaces or engines. Regulations limiting the sulphur content of gas oils have been made under this section.

3.2 Mobile Sources

Emissions from motor vehicles are affected both by the structure of the vehicle and the composition of the fuel used. Emissions from vehicles are controlled principally by the Motor Vehicles (Construction and Use) Regulations 1973 made under the Road Traffic Act 1972. These regulations have for many years required motor vehicles to be so constructed that no avoidable smoke or visible vapour from them causes, or is likely to cause, injury to other road users or damage to property. There are other regulations dealing with specific parts of the vehicle or types of vehicle which are designed to reduce one or more of the different kinds of emission from vehicles (e.g. smoke, hydrocarbons, carbon monoxide), including the ECE regulations on motor vehicle emissions.

Attention is now being given to reducing pollution from vehicle exhaust by regulating the contents of the fuel used, in particular lead. In 1971 the Government was advised by the Chief Medical Officer of the Department of Health and Society Security (DHSS) that, although the levels of lead emissions from vehicles at that time did not offer any significant danger to the community as a whole, it was desirable that such levels should not rise and should, if possible, be reduced. Policy is still to contain emissions at or below the 1971 level. The maximum lead content of petrol has been progressively reduced from 0.84 grams per litre in 1971 to 0.45 grams per litre in 1978. Since 1976 the controls have had the statutory backing of Regulations made under section 75 of the Control of Pollution Act 1974. In January 1981 the lead content of petrol will be further reduced to 0.40 grams per litre.

Emissions from aircraft are controlled by the Department of Trade.

4. INTERNATIONAL CONSIDERATIONS-EEC HPS DIRECTIVE

The UK has up until now relied on the pragmatic approach embodied in the "best practicable means" philosophy in air pollution control. The impending finalization of the EEC Health Protection Standards (HPS) Directive represents a significant change in emphasis towards air quality standards, although the UK Royal Commission on Environmental Pollution proposed the establishment of air quality guidelines for a number of atmospheric pollutants.

The Directive sets maximum permitted concentrations for smoke and SO_2 on an annual, winter and daily basis; it leaves the measures to be taken to achieve the standards up to the member states, and there is likely to be some derogation to allow extra time for the standards to be achieved in areas where there are structural difficulties such as exceptionally heavy concentrations of industry.

In practice, the UK will be able to implement the Directive largely through extensions of domestic smoke control, though in some areas such as Central London it will probably be necessary to use the powers in the Control of Pollution Act 1974 to regulate the sulphur content of fuel oil used. The City of London has already done this under its own private legislation. A detailed analysis of the areas of the UK likely to be involved in control measures and an evaluation of different control strageties is at present being undertaken for the DoE by Warren Spring Laboratory.

Herschel H. Slater
Joseph P. Tikvart

PHILOSOPHY OF AIR QUALITY MANAGEMENT IN THE UNITED STATES OF AMERICA

The fundamental approach to control of air pollution in the United States is air quality management. This approach is dictated by the Clean Air Act, enacted in 1963 and amended several times, most recently in 1977. The Act, and the numerous court decisions which interpret the meaning of the Act, form the legal bases for the Nation's effort to provide a clean air environment for its citizens[1].

Under the Act, the United States endeavors to protect and enhance the quality of the Nation's air resources through the cooperative efforts of Federal, State, Regional and local governments. The States and local governments retain primary responsibility for the prevention and control of air pollution at its source. The Federal Government provides leadership and financial assistance for the development of cooperative and effective air pollution control programs.

The Environmental Protection Agency (EPA) is the Federal body responsible for administering the Clean Air Act. It establishes the national ambient air quality standards for a number of pollutants and assesses the State's plans to attain and maintain the standards. A State may establish more stringent ambient air quality standards than those promulgated by the Federal Government. However, each State must in its implementation plan show how its emission limitations, its enforcement procedures and its schedules for compliance will enable the national ambient air quality standards to be met in a reasonable, timely, and effective manner.

Before proceeding with a discussion of air quality management as practiced in the United States, it is worthwhile to carefully define some terms as they are applied in the United States.

a) Air quality criteria:

Statements which indicate the kind and extent of effects on the public health and welfare which may be expected from the presence of a pollutant in the ambient air. The criteria shall reflect the latest scientific knowledge and, to the extent practicable, include the variable factors which of themselves or in combination with other factors may alter the effects on the public health or welfare of such an air pollutant[2].

b) Air quality standard:

Legal limits placed on levels of air pollutants in the ambient air during a given period of time[3]. In the United States, two levels of standards may be, but not necessarily, designated at the national level. National primary ambient air quality standard: a standard, based on air quality criteria and allowing an adequate margin of safety, the attainment and maintenance of which in the judgement of the EPA Administrator is requisite to protect the public health[4]. National secondary ambient air quality standard: a standard, based on air quality criteria, the attainment and maintenance of which in the judgement of the EPA Administrator is requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air[4].

c) Emission limitations:

Legally binding maximum allowed emission for a certain type of process, plant or installation, often expressed in terms of concentrations or mass flow rates per pollutant, or of plume visibility[5]. Emission standards are set by the federal level for various categories of new stationary and mobile sources.

d) Air quality simulation model or "Model":

A mathematical technique, based on physical principles, for estimating pollutant concentrations in space and time as a function of emissions and attendant meteorological conditions.

e) Ambient air quality:

The quality of the ambient air near ground level, expressed as concentrations or deposition rates of air pollutants[5].

The air quality management approach as practiced in the United States, is founded on a set of ambient (outdoor) air quality standards. The management of air quality consists of regulating the amount, location and time of emissions of pollutants so that the ambient air quality standards are attained and maintained.

Air quality management as generally practiced in the United States also requires a methodology to relate ambient air quality to pollution emissions, and vice versa. This methodology is often termed an air quality simulation model (AQSM). If the AQSM is accepted, and its inputs (emission and meteorological data) are accurate and sufficiently precise, then the model outputs (predicted ambient air quality) are compared to the ambient air quality standards. If the standards are predicted to be exceeded, an appropriate change is made to the emission limitation for an existing source or the emission standard for a new source. If the source or sources are proposed facilities, a number of further options may be exercised: control devices may be altered, the facility's location may be changed or its configuration redesigned. Iterations of the analysis of the impact follow until there is confidence that the air quality standards will be met.

There is a slight difference in approaches to establishing emission limitations between the NATO/CCMS Document No. 71[6] and the common practice in the United States. In the United States the emission limitations/standards are established at a level sufficiently stringent to enable the ambient air quality standards to be attained and maintained so that a feedback system is utilized. In doing so, the capability to control existing sources (generally analogous to "best practical control technology") and the capability to control new sources (generally analogous to "best available control technology") are carefully considered. Theoretically, at least, no more control is applied than is necessary to meet air quality standards. In the NATO/CCMS document the formulation of emission limitations is governed by best practical or best available control technology.

The NATO/CCMS document also considers equipment and product standards. Although EPA has the prerogative to promulgate equipment design or work practice standards in lieu of standards of performance (emission limits) for new sources, such actions are generally taken with extreme reluctance and caution. This policy is followed to provide and retain as much flexibility as to how to control emissions in the private and industrial sectors as possible. The EPA carefully reviews equipment and work practices. In fact, it engages in considerable research and development, often in concert with private companies and industrial groups, to devise processes that are more economical and have emissions which have less adverse impacts on the environment than currently used processes. The general goal is to avoid equipment and product standards in favor of an emission standard for a source category. The choice of how the emission standard is met is largely the prerogative of the source operators.

There are important exceptions to the "pure" air quality management approach in the United States. The most notable pertains to mobile source emissions, particularly the automobile. The United States Congress specified emission standards for new motor vehicles in the Clean Air Act rather than directing EPA to set the standards or allowing EPA to approve the emissions standard for automobiles chosen by the States. California, where the photochemical smog problem was first recognized and associated with pollutants emitted from motor vehicles, is the only State permitted to enact its own vehicle emission standards. They must be more stringent than the national automobile emission standards and EPA must judge them to be technically feasible. By placing emission standards for mobile sources into law, the Congress indicated an intent to limit authority of administrative agencies to modify the standards. This action has served to place pressure on automobile manufacturers and has stimulated a large research and development effort by the automobile industry to produce the needed control systems. It has also produced a great deal of controversy over the basis, feasibility, costs, need, and benefits of standards written into law[7].

A technique which theoretically meets the most fundamental requirements of air quality management systems is the intermittent control of pollutant emissions. The technique, which has been labeled intermittent control systems (ICS), supplementary control systems (SCS), sulphur dioxide emission limitations (SDEL), etc., recognized that there are certain time-periods when emissions are more likely to cause high ambient concentrations than other time-periods. An intermittent control system attempts to reduce emissions during such periods and to return to normal rates at less critical times. The reduction

of emissions is effected by fuel switching, production curtailment or plant shutdown. ICS techniques have been suggested most often for large industrial facilities such as electric generating plants and nonferrous smelters. They also might apply to open burning for agricultural and forestry purposes, alterning work schedules to lessen peak levels form mobile sources or to the allocation of long distance natural gas supplies to interruptible users based on expected air quality[8].

The use of intermittent control systems for large point sources has been challenged on the basis that they cause a minimum, if any, reduction in total emissions. Hence, they are alleged to be inconsistent with the Act's purpose to protect and enhance the Nation's air resources by emission reductions. They also place a costly burden on the local air pollution agency to enforce the control system. Such agencies are often staffed with the least experienced personnel; however, the criteria for executing the intermittent control system is generally subtle meteorological factors that require particularly trained or experienced personnel to evaluate. Consequently, the use of intermittent control systemshas largely been confined to large facilities that have limited life expectancy and, as a consequence, for which continuous emission controls are not cost-effective.

The tall stack tactic is based on the fact that, in all but rare circumstances, raising the height of the emission will reduce the maximum ground-level concentration. This can be considered an air quality management tool. This tactic makes particular sense for single sources in remote areas[8]. However, concerns that long-lived pollutants may impact in distant populated areas, that they may impact in areas not in the same pollution control district, that the emitted pollutants may serve as precursors for other pollutants, and that the use of tall stacks may be inconsistent with the purpose of the Clean Air

Act have led to numerous legal actions on the use of stack height as a control mechanism. The Congress in the Clean Air Act Amendments of 1977 severely limited the use of the tall stack. It ruled against credit being given for stacks higher than necessary to prevent eddies, wakes and downwash in the lee of the facility and nearby obstructions[91].

Air quality management systems have been found to be difficult to apply to problems involving highly reactive pollutant species, particularly where the emissions are omnipresent as are mobile source emissions in large metropolitan areas. They are not easily used to deal with secondary pollutants, such as sulfates, nitrates and fine particulates. These pollutants tend to be products of atmospheric chemical reactions and are only detected several hours after the time and considerable distance from the place that their precursors are emitted. The analytic procedures (models) needed to describe the transport, dispersion and transformation of these pollutants so as to relate emissions and ambient air quality are much more sophisticated than models which often give satisfactory results for less reactive species. Further, these problems often demand very detailed and precise information which is difficult and costly to acquire.

In summary, the Clean Air Act basically prescribes the use of a form of air quality management to enhance and protect the Nation's air resources. However, the United States attempts to apply a more stringent form of air quality management than is generally brought out in NATO/CCMS Document No. 71. The emission limit is theoretically determined at a level such that ambient air quality standards are attained and maintained. Air quality management has been used with particular success for controlling relatively stable pollutants, especially where the pollutants impact significantly within 10 - 20 kilometres of the source. There are difficulties in extending the air quality management principles to all pollutants and to all circumstances with equal effectiveness. The difficulties have in some instances been sufficiently great that a few theoretically supported air quality management techniques are not generally applied.

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PHILOSOPHY OF THE AIR QUALITY MANAGEMENT SYSTEM IN THE FEDERAL REPUBLIC OF GERMANY

Hans Ludwig Dreißigacker

Fritz Surendorf

Erich Weber

1. DESCRIPTION OF THE AQMS

The AQMS in the Federal Republic of Germany consists of

- measures in connection with the licensing procedures for industrial plants
- air quality maintenance plans for larger polluted areas and
- limitations of the use of special products.

Therefore in Germany the Federal Government has given by law

- emission standards,
- minimum requirements for stack heights,
- ambient air quality standards and threshold values,
- equipment standards,
- requirements for emission declarations and inventories as well as for the assessment of ambient air concentrations,
- requirement for siting and land use, and
- principles of avoiding degradation of air quality in remoted areas.

The practical application of the building blocks of an AQMS (emission-, stack height-, product and air quality standards and threshold) shall be described. These standards are set by the Federal Government in order to keep air pollution as low as possible and, in connection with local air quality maintenance plans, to improve air quality in polluted areas. The philosophy of the AQMS in Germany can be summed up:

1. The emissions should be kept as low as possible by applying the latest state of technology to emission, product and equipment standards.

2. The inevitable emissions should be distributed by stacks into the atmosphere. It is required that the ambient air ground level concentrations caused by the emission of a single stack be not higher than about one or two percent of the immission standards (Table 1).

3. The immission standards should never be exceeded. If the concentration of the pollutants is higher, an air quality maintenance plan has to be made and enforced.

2. THE SIGNIFICANCE OF AIR POLLUTION CONTROL STANDARDS

In the Federal Republic of Germany air quality standards and emission standards are implemented on the basis of the "Law for the Prevention of Harmful Effects on the Environment caused by Air Pollution, Noise, Vibration and Similar Phenomena" (Official translation) - Federal Air Quality Control and Noise Abatment Act - Bundes-Imissionsschutzgesetz - BImSchG, as of 1974.

This law is a continuation and modernization of the Commerce and Industry Act from 1869 (Gewerbeordnung) with respect to air pollution control and is thus based on a more than 100 years experience and tradition in judiciary and administration praxis.

Para. 1 of the BImSchG, defining the purpose of the law and thus its goals, stipulates with respect to air pollution control:

1. Men, animals, plants and other objects must be protected against such pollutants, which potentially may cause danger, considerable disadvantages or considerable nuisance, because of their nature (proprieties), extent (volume, significance) and duration (periods of emission, life-time in the environment).

2. Prevention must be taken against the generation of air pollutants.

Installations comprising a particular potential to cause harmful effects on the environment have to be granted a licence. For the licensing of such installations the Federal Government has implemented air quality and emission standards by the 1st General Administrative Regulation under the BImSchG, dated 28. August 1974, as "Technical Instructions for Air Pollution Control" - (Technische Anleitung zur Reinhaltung der Luft - TA Luft).

Such administrative regulations can only be imposed after hearing the competent social groups concerned and in agreement with the Federal Council (State Chamber - Bundesrat).

Air quality and emission standards are of vital importance for installations subject to licensing. They form the basis for any administrative activity for all of the licensing procedures provided by the law, enabling plant operators to take account of them when planning and deciding on investments. Those standards, however, equally ensure the vicinity of such installations as the public in general, that the environment is being protected against harmful effects from air pollution.

Air quality standards

Air quality standards shall not just protect the environment against harmful effects, they equally shall take provision against such effects.

As of today there is a need for air quality standards for about 300 substances and their chemical compounds. This, however, would require that as a basis for such standards elaborated criteria are at the disposal of the decision makers.

A criterium shall be defined as the relation between the extent of encumbering an object by a harmful substance and the significance of the harmful effects to which that object consequently is subjected.

For the TA Luft 1974 ensured criteria should be disposed of only for dustfall, suspended particulate matter, chlorine, hydrogen chloride, hydrogen fluoride, carbon monoxide, sulfur dioxide, hydrogen sulfuride, nitrogendioxide and -monoxide (Table 1).

Criteria as a basis for air quality standards must be oriented towards preventing as well as taking provision against

- dangers for the health of men including those already affected (e.g. by bronchitis) or sensible ones (pregnants, babies)
- considerable nuisances of men (bad smell)
- considerable disadvantages (e.g. by injuring property like animals, plants and other goods).

Air quality standards have no meaning just as numbers but only in connection with defined measuring and evaluation procedures for the assessment of air quality. Such procedures are prescribed as well in the TA Luft. They are based on the experiences of long term monitoring programmes. They ensure measurements being carried out in such a way, that a comparison of the results with air quality standards gives sufficiently safe evidence, that the vicinity and the public in general are protected. Those procedures are thought also to limit the costs of measurement programmes. When transmitting criteria to air quality standards the following has to be looked upon:

Criteria for the individual substances are based on the work of WHO, NATO/CCMS, the European Communities and the Air Pollution Control Commission of the Association of German Engineers (Verein Deutscher Ingenieure - VDI). There are no well defined boundaries between harmful and non-harmful effects. Such blurs or blurred areas may sum up during the elaboration of criteria. Criteria therefore do not correspond to the air quality standards as defined by the BImSchG - neither qualitatively nor quantitatively. If criteria differ quantitavely from air quality standards, the latter ones include a safety margin. Therefore it is not tolerable that the blurred areas adherent to criteria being transmitted to air quality standards when implementing them. Air quality standards mean strict limits.

Air quality standards normally are defined as a pair of standards: one for long term[1)] effects, the other one for short term[2)] effects.

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1) arithmetic mean of all half hourly averages per year

2) 95 percentile of all half hourly averages per year

On September 6th, 1978, the Federal Government by an amendment of the TA Luft decided on additional air quality standards for dustfall and suspended particulate matter of lead and cadmium (Table 1).

Furthermore a standardized dispersion model was to be prescribed to enable the prognosis of the changes in air quality caused by projected new installations or by alterations of existing ones.

(Additionally a set of threshold values for the protection of animals, plants and materials was established (Table 2)). On the same day the Federal Government decided on an ordinance concerning the annual declaration of the emission of an installation, to be given by the operator, and simultaneously the Federal Government decided on an administrative regulation concerning regional emission inventories to be installed by the competent authorities. The instruments for local and regional air quality management provided by the BImSchG are thus further completed.

Emission standards

Because of the above cited requirements of the BImSchG, rather rigid limits are set for economic considerations during the establishment of air quality standards. This is not valid to the same extent for emission standards. They are based on the latest "state of technology".

The TA Luft 1964 defined the "state of technology" as follows:

> When judging, whether - considering the special circumstances of the particular case - the actual state of technology can be achieved, advanced comparable processes and plant installations proven by operation are to be considered.

The requirements "proven by operation" was a static element in that definition, impending the progress of technology.

There were in fact considerably different conditions for the innovation of environmental and productive technologies:

The former ones first had to demonstrate being proven by operation, the latter ones normally are transmitted into economic plant size after pilot plant demonstration, employing scale up factors.

The legislator, drawing consequences from this unsatisfactory situation, defined the state of technology in accordance with general economic practice as follows:

> The latest state of technology in the sense of this law shall mean that state of development of advanced processes, facilities or operation methods, at which a method of controlling emissions appears certainly to be suitable for practical application. In determining the latest state of technology comparable processes, facilities or operation methods, which have been proven successful by operation, shall particularly be considered.

For the purposes of air pollution control the TA Luft in 1974 made this legal definition precise as follows:

> Advanced methods for controlling emissions, which have been proven by operation, shall particularly be considered to be the latest state of technology. Methods which are not conclusively proven by operation for the respective application may be considered to be the la-

test state of technology in substantiated cases, e.g. if they are proven to such an extent, that the projected application is feasible without an unreasonable risk. Comparable operation methods, facilities or processes shall particularly be considered when determining the latest state of technology for the respective application. If such operation methods, facilities or processes do not exist, particularly stringent requirements shall be applied to the judgement, whether a method of controlling emissions appears certainly to be suitable for practical application.

The legal definition and its precision by the TA Luft 1974 remove the above mentioned impediment to the progress of air pollution control technology while protecting tne plant operator against undue risks when transmitting just developed processes to industrial application (Annex 1).

For the implementation of emission standards according to the latest state of technology the principle has to be observed, that the relation of the means must remain within due proportions. Excessive requirements are thus not permitted. I.e. generally binding emission standards which would call in question the economic basis of an industrial branch are not tolerable. Emission standards are based in general upon the results of measuring programmes executed in modern installation.

The significance of important single sources for regional air quality management is taken into account by emission control requirements raising by increasing size of installations.

Administrative regulations like the TA Luft are obliging the competent authorities. They may deviate from those obligations in substantiated cases only. Subsequent requirements for plants in operation shall be limited to certain condi-

tions defined by the TA Luft except in those cases, where the vicinity or the public in general is not sufficiently protected against harmful effects to the environment.

Emission standards include a certain safety margin considering possible fluctuations of plant operation. This is necessary since frequent exceedings of the emission standards would mean a violation of the law and this would lead to severe fines. This safety margin is also important where plant operation is automatically stopped when emission standards are exceeded. Too restrictive standards would lead to too frequent plant shut down.

3. CONCLUSION

Air quality and emission standards as set forth in the TA Luft give industry the possibility to assess the decisions of the licensing authorities and thus to dispose of an ensured basis for planning and deciding on investments. Air quality maintenance plans and a non-degredation policy will ensure improvements in polluted areas and provisions in rural areas.

ANNEX 1

EMISSION STANDARDS FOR SPECIAL SUBSTANCES

Emission Standards for Particular Dust Materials in Waste Gases:

The materials in particular dust emissions of a waste gas which are broken down into classes I through III in the list given below shall not exceed the following mass concentrations even if several materials in the same class are present:

Materials in class I at a mass flow of 0.1 kg/h or more,	20 mg/m^3
Materials in class II at a mass flow of 1 kg/h or more,	50 mg/m^3
Materials in class III at a mass flow of 3 kg/h or more.	75 mg/m^3

In the presence of materials in several classes - notwithstanding Clause 1 - the mass concentration in waste gas shall not exceed a total of 50 mg/m^3 if materials in classes I and II occur together, and mass concentration in the waste gas shall not exceed a total of 75 mg/m^3 if materials in classes I and III and classes II and III occur together.

Substance	Class
Aluminium carbide	III
Aluminium nitride	III
Ammonium compounds	III
Antimony and its soluble compounds*)	II
Arsenic and its soluble compounds*)	I
Asbestos	I
Barium sulfate	III
Barium compounds, if soluble*)	II
Beryllium and its soluble compounds*)	I
Bitumen	III
Boron trifluoride	II
Boron compounds, if soluble*)	III
Lead and its soluble compounds*)	I
Cadmium and its soluble compounds*)	I
Calcium arsenate	I
Calcium cyanamide	III
Calcium fluoride	II
Calcium hydroxide	III
Calcium oxide	III
Chromium compounds, if hexavalent	I
Cristobalite with particles smaller than 5 µm	II
Fluorine compounds, if soluble*)	I
Fluorspar	II
Iodine and its compounds	II
Diatomaceous earth	II
Cobalt and its compounds	II
Copper and its soluble compounds*)	III
Copperas	I
Magnesium hydroxide	III
Magnesium oxide	III
Molybdenum and its soluble compounds*)	III

*) Soluble compounds are those materials which are soluble in the respiratory and digestive tracts, on the surface of the skin or in the absorbing organs of plants to such a degree that they can cause hazardous effects.

Substance	Class
Nickel	I
Nickel carbonate	I
Nickel oxide	I
Nickel sulfide	III
Phosphates	I
Phosphorus pentoxide	II
Quartz with particles smaller than 5 µm	I
Mercury and its compounds, except cinnabar	II
Soot	I
Selenium and its soluble compounds *)	II
Silver compounds, very soluble, e.g. silver nitrate *)	III
Ferrosilicon	III
Silicon carbide	II
Strontium and its compounds	II
Tar	II
Cutback pitch	I
Tellurium and its soluble compounds *)	I
Thallium and its compounds	II
Tridymite with particles smaller than 5 µm	I
Uranium and its compounds	I
Vanadium and its compounds	III
Bismuth	III
Tungsten and its compounds, except tungsten carbide	II
Zinc and its compounds	
Dusts of organic compounds, e.g. anthracenes, aromatic amines, 1,4-Benzoquinone, naphtalene	II

*) Soluble compounds are those materials which are soluble in the respiratory and digestive tracts, on the surface of the skin or in the absorbing organs of plants to such a degree that they can cause hazardous effects.

Limiting Emissions of Vaporous or Gaseous Organic Compounds in Waste Gas

Vaporous or gaseous emissions of organic compounds contained in waste gas, which are broken down into classes I through III in the list below, shall not exceed the following mass concentration, even if several organic compounds of the same class are present:

Organic compounds in class I at a mass flow of 0.1 kg/h or more,	20 mg/m^3
Organic compounds in class II at a mass flow of 3 kg/h or more,	150 mg/m^3
Organic compounds in class III at a mass flow of 6 kg/h or more.	300 mg/m^3

If organic compounds in several classes are present -- notwithstanding Clause 1 -- mass concentration in the waste gas shall not exceed a total of 300 mg/m^3.

Substance	Chemical Formula	Class
Acetaldehyde	CH_3CHO	II
Acetone	CH_3COCH_3	III
Acrolein	CH_2CHCHO	I
Acrylonitrile	CH_2CHCN	I
Acrylic acids	$CH_2CHCOOH$	I
Ethylacrylate	$CH_2CHCO_2C_2H_5$	I
Methylacrylate	$CH_2CHCOCH_3$	I
Formic acid	$HCOOH$	I
Amyl acetate	$CH_3COOC_5H_{11}$	II
Aniline	$C_6H_5NH_2$	I
Ethanol	C_2H_5OH	III
Ethylbenzene	$C_6H_5C_2H_5$	II
Ethyl chloride	CH_3CH_2Cl	III
Ethylenediamine	$H_2NCH_2CH_2NH_2$	II
Ethylene glycol	$HOCH_2CH_2OH$	III
Ethyl glycol	$C_2H_5OCH_2CH_2OH$	III
Glycol monomethyl ether (methylglycol)	$CH_3OCH_2CH_2OH$	II
Ethylenimine	CH_2NHCH_2	I
Ethylene oxide	CH_2OCH_2	I
2-Ethyl-1-hexanol	$CH_3(CH_2)_3CH\cdot(C_2H_5)CH_2OH$	II

Substance	Chemical Formula	Class
Gasoline containing more than 25 % C_7 and C_8 aromatics by weight		II
Benzene and solvents containing more than 1 % benzene by weight	C_6H_6	I
Tetraethyl lead	$Pb(C_2H_5)_4$	I
1,3-Butadiene	$CH_2CHCHCH_2$	II
i-Butanol	$(CH_3)_2CHCH_2OH$	III
n-Butanol	C_4H_9OH	III
n-Butyl acetate	$CH_3COOC_4H_9$	III
Butyric acid	C_3H_7COOH	I
Caprioc acid	$CH_3(CH_2)_4COOH$	I
2-Chloro-1,3-butadiene	$CH_2CClCHCH_2$	II
Chloracetic acid	$CH_2ClCOOH$	I
Chloropropionic acid	$CH_3CHClCOOH$	I
Cyclohexane	C_6H_{12}	III
Cyclohexanol	$C_6H_{11}OH$	III
Cyclohexanone	$C_6H_{10}O$	II
Diacetone alcohol	$(CH_3)_2C(OH)\text{-}CH_2COCH_3$	II
Diethanolamine	$(OHCH_2CH_2)NH$	II
Diethylamine	$(C_2H_5)_2NH$	I
Diethyl ether	$(C_2H_5)_2O$	III
Dibromoethane	CH_2BrCH_2Br	II
1,1-Dichloroethane (ethylene chloride)	$CHCl_2CH_3$	II
1,2-Dichloroethane	$ClCH_2CH_2Cl$	I
1,2-Dichloroethylene	CHClCHCl	III
p-Dichlorobenzene and o-Dichlorobenzene	$C_6H_4Cl_2$	II
Dichloromethane	CH_2Cl_2	III
Dichlorophenol	$C_6H_3Cl_2OH$	I
Dimethylethylamine	$(CH_3)_2C_2H_5NH_2$	I
Dimethylamine	$(CH_3)_2NH$	I
Dimethyl aniline	$C_6H_5N(CH_3)_2$	I
Dimethylformamide	$HCON(CH_3)_2$	II
Dimethyl sulfide	CH_3SCH_3	I
Dimethyl sulfate	$(CH_3O)_2SO_2$	I

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Substance	Chemical Formula	Class
Dimethylsulfoxide	$(CH_3)_2SO$	III
Dinitrobenzenes	$C_6H_4(NO_2)_2$	I
1,4-Dioxane	$C_4H_8O_2$	II
Biphenyl	$(C_6H_5)_2$	I
Diisopropylether	$(CH_3)_2CHOCH(CH_3)_2$	III
Epichlorohydrin	$CH_2(O)CHCH_2Cl$	I
Acetic acid	CH_3COOH	II
Ethyl acetate	$CH_3COOC_2H_5$	III
n-Amyl acetate	$CH_3COOC_5H_{11}$	II
n-Butyl acetate	$CH_3COOC_4H_9$	III
Methyl acetate	CH_3COOCH_3	II
Vinyl acetate	$CH_3COOCHCH_2$	II
Formaldehyde	HCHO	I
Furfurol	$C_5H_4O_2$	I
n-Heptane	C_7H_{16}	III
Hexamethylene-1,6-Diisocyanate	$OCN(CH_2)_6NCO$	I
n-Hexane	C_6H_{14}	III
4-Hydroxy-4-methyl-2-Pentanone	$(CH_3)_2C(OH)CH_2\cdot COCH_3$	III
Cresols	$C_6H_4(CH_3)OH$	I
Ketene	CH_2CO	I
Mercaptans		I
Methyl methacrylate	$CH_2C(CH_3)COOCH_3$	II
Methanol	CH_3OH	III
Methylamine	CH_3NH_2	I
Methyl ethyl ketone	$CH_3COC_2H_5$	III
Methyl butyl ketone	$CH_3CO(CH_2)_3CH_3$	III
Methylcyclohexane	$C_6H_{11}CH_3$	III
Methylcyclohexanone	$CH_3C_5H_9CO$	II
Methyl isobutyl ketone	$(CH_3)_2CHCH_2\ COCH_3$	III
Methyl isocyanate	CH_3NCO	I
Methylnaphtalene	$C_{10}H_7CH_3$	II
Monoethylamine	$C_2H_5NH_2$	I
Morpholine	$O(CH_2)_4NH$	II
Monoethanolamine	$H_2NCH_2CH_2OH$	II
Monochlorobenzene	C_6H_5Cl	II
Naphthalene	$C_{10}H_8$	II
Nitrobenzene	$C_6H_5NO_2$	I
Nitrocresol (2-nitro-p-cresol)	$CH_3C_6H_3OHNO_2$	I

Substance	Chemical Formula	Class
Nitrophenols	$NO_2C_6H_4OH$	I
Nitrotoluenes	$NO_2C_6H_4CH_3$	II
n-Pentane	C_5H_{12}	III
l-Pentanol	$C_5H_{11}OH$	III
Phenol	C_6H_5OH	I
Phosgene	$COCl_2$	I
Pinene	$(CH_3)_3(Cl_2)_2C_5H_3$	III
Polychlorinated biphenyls (Clophen)		I
i-Propanol	$(CH_3)_2CHOH$	III
i-Propyl ether	$(CH_3)_2CHOCH(CH_3)_2$	III
Propylene oxide	CH_3CHCH_2O	II
Propionic acid	C_2H_5COOH	II
Pyridine	C_5H_5N	I
Carbon disulfide	CS_2	II
Styrene	$C_6H_5CHCH_2$	II
Tetrachloroethane	$C_2H_2Cl_4$	I
Tetrachloroethylene	Cl_2CCCl_2	III
Carbon tetrachloride	CCl_4	I
Tetrahydrofuran	C_4H_2O	II
Tetrahydronaphthalene	$C_{10}H_{12}$	II
Thioether	C_4H_8S	I
Thiocresol	$CH_3C_6H_4SH$	I
Thiophenol	C_6H_5SH	I
Toluene	$C_6H_5CH_3$	II
Tolylene diisocyanate	$CH_3C_6H_3(NCO)_2$	I
Triethanolamine	$(CH_2OHCH_2)_3N$	II
Triethylamine	$(C_2H_5)_3N$	I
Triethylene glycol	$HOC_2H_4OC_2H_4OC_2H_4OH$	III
Trimethylamine	$(CH_3)_3N$	I
1,1,1-Trichloroethane	CH_3CCl_3	III
1,1,2-Trichloroethane	$CH_2ClCHCl_2$	I
Trichloroethylene	CCl_2CHCl	II
Trichloromethane (Chloroform)	$CHCl_3$	II
Trichlorophenol	$C_6H_2Cl_3OH$	I
Trioxane	$(CH_2O)_3$	II
Valeric acid	$CH_3(CH_2)_3COOH$	I
Vinyl chloride	CH_2CHCl	II
Xylene	$C_6H_4(CH_3)_2$	II

Emission limits for carcinogenic substances

The emissions of the following air pollutants in the waste gas shall not exceed a mass concentration in the waste gas of 5 mg/m^3, even if more than one of these substances are emitted at the same time. Moreover, they shall be limited further to the extent possible.

Arsenic and its compounds - given as As -

asbestos

benzpyrene

beryllium and its compounds - given as Be -

Chromium (VI) compounds, in the case of calcium chromate
Cr(III) chromate
strontium chromate
and
zinc chromate - given as Cr -

1,2 - Dibromoethane

Nickel and its compounds, in the case of
nickel carbonate
nickel carbonyl, nickel oxide
and nickel sulphide - given as Ni -

Table 1: IMMISSION STANDARDS

Substance	Unit	TA Luft 1974		TA Luft 1978	
		long term-effects	short term-effects	long term-effects	short term-effects
Dustfall	$mg/m^2 \cdot day$	350	650	350	650
Suspended particulate matter	$\mu g/m^3$	200/100*	400/200*	150	300
Chlorine	$\mu g/m^3$	100	300	100	300
Hydrochloricacid	$\mu g/m^3$	100	200	100	200
Hydrogenfluoride	$\mu g/m^3$	2	4	1	3
Carbonmonoxid	mg/m^3	10	30	10	30
Sulfurdioxid	$\mu g/m^3$	140	400	140	400
Hydrogensulfide	$\mu g/m^3$	5	10	10	20
Nitrogendioxid	$\mu g/m^3$	100	300	80	300
Nitrogenmonoxid	$\mu g/m^3$	200	600	200	-
Lead					
- dustfall	$\mu g/m^2 d$	-	-	500	-
- suspended particulate matter	$\mu g/m^3$	-	-	2	-
Cadmium					
- dustfall	$\mu g/m^2 d$	-	-	7.5	-
- suspended particulate matter	$\mu g/m^3$	-	-	0.04	-

* Two different imission standards, because of two different measuring systems

Table 2: CRITERIA FOR THE PROTECTION OF EXISTING ANIMALS, PLANTS AND MATERIALS

Type of air pollution	Object to be protected	Air quality treshold value
Lead	Fishery, fruit and vegetable crops, except for root vegetables	250 $\mu g/m^2 d$
Lead	Cattle, sow and sheep breeding	500 $\mu g/m^2 d$
Cadmium	Food and animal feed corps	2.5 $\mu g/m^2 d$
Inorganic gaseous fluorine compounds	Plants and animals in nature conservation areas, spruce (Picea spec.) or plants of similar sensitivity	0.3 $\mu g/m^3$
Inorganic gaseous fluorine compounds	Common pine (Pinus silvestris) or plants of similar sensitivity	0.5 $\mu g/m^3$
Inorganic gaseous fluorine compounds	Pinus nigra austriaca or plants of similar sensitivity	1.0 $\mu g/m^3$
Sulphur dioxide	Plants and animals in nature conservation areas	20 $\mu g/m^3$
Sulphur dioxide	Firs (Abies spec.) or plants of similar sensitivity	50 $\mu g/m^3$
Sulphur dioxide	Common pine (Pinus silvestris) or plants of similar sensitivity	80 $\mu g/m^3$
Sulphur dioxide	Pinus nigra austriaca or plants of similar sensitivity	140 $\mu g/m^3$

CHAPTER III

PROBLEMS IN ADMINISTERING AIR QUALITY MANAGEMENT SYSTEMS IN SELECTED COUNTRIES

Herschel H. Slater
Joseph A. Tikvart

PROBLEMS IN ADMINISTERING AIR QUALITY MANAGEMENT SYSTEMS IN THE UNITED STATES OF AMERICA

INTRODUCTION

Air quality management systems, as do all other mechanisms for controlling air pollution, have advantages and disadvantages. The relative strengths and weaknesses of air quality management as a method of protecting the air resources are succinctly analyzed by the Nevers, et al.[1]. The basic components of an air quality management system are emissions, models and air quality. Each component has problems of various difficulty to be overcome.

This paper discusses some problems encountered in operating under a law (the Clean Air Act of the United States[2]) which is primarily based on air quality management concepts. It is useful, however, to keep these problems in perspective. No control process is without limitations; no control mechanism is without advantages.

Although much air pollution law in the United States is based on air quality management concepts, important exceptions have developed. A couple of theoretically "pure" air quality management procedures have not been adopted for practical reasons. In the case of automobile emissions, the U.S. Congress legislated emission limits for mobile sources without regard to the State in which the vehicle was registered or located. This action was taken despite the fact that problems derived from automobile emissions are encountered primarily in urban areas. In vast geographical areas of the United States automobile emissions are not of great concern, e.g., the great plains. Congress chose to impose a nationwide emission limit in part to avoid creating monstrous accounting, control, and enforcement agencies.

Similarly, certain "pure" air quality management techniques that would apply to stationary sources were found to be unacceptable by the courts. The use of very tall stacks for emitting massive amounts of pollutants and the use of intermittent control procedures for timing the emissions were deemed inappropriate for general application. The courts, considering these matters, were influenced to some degree by concerns for the more subtle effects of pollutants emitted by facilities using these procedures. The pollutants may remain airborne for a sufficient period for atmospheric chemical transformations to take place and dramatically alter the nature of the adverse effects encountered. Specifically, the apparent impacts of the oxides of sulfur and nitrogen after they have been transformed into particulate aerosols were not recognized fully at the time air pollution control legislation was originally enacted. Air quality management techniques have not developed sufficiently to handle the problems of long-range transport and atmospheric transformation effectively on a day-to-day or even month-to-month basis.

EMISSIONS

Under air management procedures as used in the United States, emissions are limited to the extent necessary to meet ambient air quality standards. The choice of the appropriate emission limitation requires consideration of many technical and economic factors. Often several, sometimes many, types of sources (source categories) contribute to the unsatisfactory air quality. It is useful to identify a level of control for each source category that might be designated a "best" or "reasonably" available control technology. This level of control can then be applied nationwide. The United States Environmental Protection Agency (EPA) has established such levels

of control technology for specific source categories, frequently by enlisting the aid of panels of recognized specialists from industry, engineering firms and universities. Because of the diversity of raw materials, fuel sources, economic factors, etc., across the Nation, general accords are difficult to obtain. The best that can be achieved for use as national normals may be averages or some least common denominators that represent less control than can be achieved by the better operated facilities in the source category.

In those cases where national norms do not exist, there is a need to specify emission limits for specific facilities within source categories. Control agencies find this circumstance very costly. They are forced to commit a disproportionate share of their manpower to perform the necessary class-by-class or facility-by-facility analysis. Further, public agencies, in comparison to the sources, are traditionally deficient in experienced manpower. So, where substantial questions as to the appropriate and available control techniques arise, this issue may become the major factor in a control agency's ability to operate an air quality management system in an efficient, cost-effective manner.

Where control technology is available and well-recognized, the problem remains of specifying the characteristics of fuels or raw materials for some operations. The sulfur content of fuel for coalfired electric generating plants is an example. If the sulfur dioxide ambient air quality standard is for a short-term, e.g., 1-, 3-, or 24-hour, it is appropriate to establish a consistent time-period for averaging the sulfur content of the coal and for specifying the averaging time of the emission limit. Although fuel can be blended it has not been common practice to manage fuel quality to limits of a few hours.

In fact, the sulfur content of coal has generally been reported as a monthly or yearly average to governmental pollution control agencies or power commissions. The technical feasibility of determining the quality of fuel on a near-continuous basis has only recently been established. However, the feasibility of controlling the quality of the fuel within very narrow limits over short-time periods is still not well established. This issue is expected to be resolved as experience in managing coal input to generating facilities is gained.

AMBIENT AIR QUALITY

STANDARDS

To manage the quality of the air effectively, the standards to be achieved should be well-supported. The bases for the selection and adoption of ambient air quality standards have not been completely resolved. This circumstance is due to no single factor. In the United States, one of the purposes of the Clean Air Act is "to enhance this quality of the Nations's air resources so as to promote the public health ...". The Act also specifies that primary ambient air quality standards shall be based on scientific knowledge as to the effects of air pollution on public health or welfare. They shall be set at levels which, "allowing an adequate margin in safety, are requisite to protect the public health"[2].

As the scientific community improves its capability of detecting and identifying contaminants in the environment and the effects of the contaminants on the health and welfare of populations who are particularly sensitive to environmental contaminants, the concepts of threshold levels and margins of safety become less valid. Some advocate that standards must provi-

de adequate protection to the most sensitive groups. This position may conflict with concepts of technical and economic feasibility or the balancing of costs and benefits. This issue is dynamic and probably is not capable of resolution to the satisfaction of all parties concerned.

MONITORING

The States and local governments gather most of the ambient air quality data. The data are collected and stored by the States, and through a computer and communications system reported to and archived by the Environmental Protection Agency. The data are used extensively by the States, EPA, and others for determining where air quality standards are attained (and where not attained), for policy analysis, and for ascertaining trends in ambient air quality nationwide.

Because several echelons of government are involved, because manpower and financial resources are not uniform among the States, and because the organizations involved have differing priorities, assuring that the data are consistently of high quality has been a continuing problem.

Nevertheless, efforts to resolve the quality assurance problem have proceeded on a number of fronts. The EPA has issued standards of performance for air sampling equipment[3]. It has specified procedures for evaluating performance at the sampling site and in the laboratory, and for evaluating the quality of the data itself as it is transferred by stages to its ultimate repository. Formats for reporting the data are prescribed. Currently, the EPA, in collaboration with the States, is designating about 1,250 sites throughout the Nation as National Air

Monitoring Stations (NAMS)[41]. The stations are selected on the basis of their representativeness of exposure and the probability that the exposure will remain unaltered in the foreseeable future. The NAMS will receive priority for resources needed to assure the accuracy and completeness of the data that are collected. The data will be reported and archived on a priority basis so that it will be available for analysis with least possible delay at the national level.

MODELS

Procedures (models) to relate the emissions of air pollutants to ambient air quality are central to a viable air quality management program. There are fundamental questions as to whether current or future models can relate these factors with sufficient precision and accuracy to satisfy all the administrative and legal aspects of a viable air quality management system. Problems include applying models for all pollutant species, for all time periods specified by ambient air quality standards, and for the infinite variety of meteorological and topographical circumstances encountered.

A significant function of the NATO/CCMS Panel on Modeling and Assessment is exchanging information on air quality models or closely related topics. The remainder of this paper is devoted to major activities in the United States to strengthen the scientific basis of models, to document their capabilities, and to resolve the fundamental questions about their use.

Drawing on similar and prior work by those involved with the military, nuclear energy, utilities, industrial activities, and research performed in other countries, EPA has devised or adopted a number of models for dealing with single (point)

and multiple pollutant sources. Many of the models were applied to meet the needs of the Clean Air Act. However, the variety of air pollution problems, of topography, and of dispersion climates across the Nation and the lack of a comprehensive scientific theory for turbulence leads to difficulty in specifying precise relationships between emissions and ambient air concentrations. This situation is particularly troublesome when all parties desire a high degree of certainty of the results in all circumstances.

The Congress recognized these problems and addressed them in the 1977 Amendments to the Clean Air Act. Two significant provisions which deal with modeling require EPA to (1) "specify with reasonable particularity" the models to be used under specified conditions, and (2) hold a conference on air quality modeling within six months and every three years thereafter[2].

In response to these requirements, the EPA proposed guidelines on air quality modeling[5]. It then held a series of technical conferences and public meetings. All concerned interests were provided an opportunity to comment on the models and the guidelines. The strengths, deficiencies and omissions that were cited were noted and studied. After a revision, the guidelines were presented and commented on at the National Modeling Conference. The guidelines were adjusted once again and issued in April 1978. They are under continuous review. The review is intensifying in preparation for the next conference to be held early in 1981.

The process of intensive scientific and public review, brought to the open the strengths and weaknesses of air quality modeling. The EPA, Department of Energy, National Oceanic and At-

mospheric Administration, Department of Interior, and Department of Agriculture have in cooperation with each other and with major elements of the industrial community, notably the Electric Power Research Institute, expanded and upgraded research and development programs aimed at better methods of associating pollution emissions and air quality. The factors receiving most attention are dispersion in complex terrain, dispersion from elevated sources, model validation, long-range transport, production and deposition of sulfates and nitrates, and impairment of visibility by man-made pollutants.

The effort to specify the systematic and consistent procedures to relate emissions and pollutant concentrations for managing the air quality has focused attention on the more pressing deficiencies of modeling. As recently as December 1979, a Federal Court of Appeals, while noting that current models in the guidelines are "flawed", ruled that EPA's models "do not contravene any discernable congressional directive". The court enjoined EPA to adopt more accurate procedures when scientific advances or better information permits. To insure that no scientific advance will go unrecognized or unheeded, the EPA has entered into a unique cooperative agreement with the American Meteorological Society. The Society will provide expertise and scientific assistance in evaluating the technical aspects of air quality models used and proposed by the EPA. Finally, a number of studies are now in progress or planned to resolve technical problem areas. Some of them are:

The Electric Power Research Institute is conducting a study to validate plume models. Its objective is to determine best procedures to test the performance of models for large single sources in different topographic settings.

Several field studies are in progress to decrease the uncertainty of modeling in particular circumstances. The EPA and the Department of Energy are conducting field studies in complicated terrain settings. The EPA is managing a large regional study on the formation and transportation of photochemical oxidants in the northeast United States. Data from regional studies of the distribution and transport of nitrates and sulfates are undergoing analysis by government, industrial and university scientists. Regional studies of the distribution and sources of acid rain are underway. The studies take full advantage of the pioneering work on this problem by numerous European scientists.

The American Meteorological Society has issued recommendations on classification schemes for dispersion coefficients and the EPA has an intensive on-going program to better specify dispersion from elevated sources, especially during periods of instability. The work encompasses the research in the past and present by European micrometeorologists.

SUMMARY

This discussion presents a number of the major difficulties encountered in the United States in implementing air quality management systems. Each component of the system has limitations. The limitations are being attacked, but resolutions that are satisfactory to all interested parties may not be available. Care should be taken to keep the weaknesses in perspective.

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* CFR - Code of Federal Regulations
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IMPLEMENTATION OF AN AIR QUALITY MANAGEMENT SYSTEM IN THE FEDERAL REPUBLIC OF GERMANY

Erich Weber

Initial Situation

The most important objective of air pollution control policy is to safeguard an air quality which will ensure human health and well-being. Health hazards must be prevented, particularly in view of long-term exposure to noxious substances. Human well-being depends on the biological environment (animals, plants, landscape, etc.) and on the material environment of man (housing, material, goods etc.).

In addition it must be ensured that air pollutants do not affect the ecological capacity of the environment over prolonged periods. The destruction of vegetation over wide areas, for example, may have negative repercussions on air quality.

The expansion of industrial production, the mechanization of wide spheres of life and heavy motorization have in the last few years even increased air pollution in partial sectors. The effect of pollutants may be increased by toxicity, prolonged exposure of high concentration in conurbation, unfavourable weather conditions, etc. Together with the large number of other adverse repercussions of civilization to which man is exposed today, air pollutants are to be regarded as serious causes of civilizational disease.

The environmental stress of the population due to air pollution is steadily increasing in concentrated areas, i.e. areas with high population densities, heavy traffic and industrialization, and requires rapid and thoroughgoing remedial and anticipatory measures because of the dangerous smog situations which may arise during weather conditions involving reduced exchange of air.

The most important sources of air pollution are: motor traffic, waste gases from industrial production, domestic heating. In the Federal Republic of Germany motor transport is responsible for 50 per cent of the total carbon monoxide emissions, for 25 per cent of the total nitrogen oxide emissions and for 19 per cent of the total hydrocarbon emissions. The pollutants are mainly emitted in downtown and housing areas, and, what is more important: at breathing height. The contribution of motor emissions to the total ambient air pollution in the inner-city "canyons" may rise to daytime levels of 94 to 99 per cent for carbon monoxide, to 76 to 89 per cent for hydrocarbons and to 83 to 93 per cent for nitrogen oxides. As a consequence of the Lead in Petrol Act, lead emissions in conurbations have decreased by 65 per cent. Further measures for reducing pollutants in motor exhaust gases are required, especially since a further increase in motorization is to be expected. According to the present forecasts, the number of motor vehicles (including tractors used in agriculture) will increase to 22.2 millions by 1980. This corresponds to a motorization density of 354 vehicles/1.000 inhabitants.

Industry, including power plants and district heating facilities, is responsible for the major part of total dust emissions, above all through its stationary firing installations. In 1974 about 1.2 million metric tons were emitted. Moreover, industry is the major emitter of fluorine compounds - in 1971, for example, it was responsible for 57 per cent of the total emissions of about 48 000 metric tons -, of organic vapours and gases - in 1975, for example, it was responsible for 77 per cent of the total emissions of about 1.3 million metric tons -, and of nitrogen oxides - in 1975, for example, its share in the total emissions of about 1.4 million metric tons was 69 per cent -. However, even in the case of

a further rise in the production levels of manufactured goods and energy it is to be expected that the planned and implemented pollution control measures, especially in the case of sulphur oxides, fluorine compounds, organic vapours and gases and dust, will be successful.

The private households contribute to a particularly high degree e.g. to the emission of carbon monoxides and chlorofluoromethanes from spray cans. Carbon monoxide emissions from domestic firing installations amount to 4 million metric tons (according to figures from 1974). The use of spray cans in private households, such as for cosmetic and hygienic purposes, is responsible for the release of about 50 000 metric tons of chlorofluoromethanes per year into the atmosphere (according to figures of 1975). These emissions have a lasting adverse effect on the earth's ozone shield.

In her 1971 Environmental Programme the Federal Republic of Germany had requested a complete revision of air quality control legislation to provide not only instruments for warding off dangers but also for anticipatory environmental management.

This work was completed with the Federal Air Quality Control Act (BimSchG) which came into effect on 1st April, 1974. This Act contains above all regulations governing the control of air pollution and noise. It contains instruments such as specifications on authorizing procedures, air pollution control plans, emission inventories and novel organizational models, including the appointment of immission control officers in factories. The Act also provides the legal basis for legal and administrative regulations and for the intervention of

public authorities. The effects of these regulations for translating objectives laid down in law into concrete action in the field of air pollution control are felt only now because of the time required for planning and implementation in administration and industry.

The measures taken by the Federal and the individual Laender authorities have prevented a proportional increase in air pollution in the conurbations despite of a further on-going increase in production and consumption. This becomes evident from figures obtained with regard to emissions and air quality fluctuations for the major air pollutants in the last few years and for several monitoring stations which have been working continuously over a prolonged period. The corresponding figures have been compiled in Table 1.

The data given in Table 1 show that air pollution by deposited and suspended particulate matter in the Federal Republic of Germany in the last 10 - 15 years has been reduced by an average of 30 to 70 per cent depending on the urban area concerned.

The corresponding figures concerning the reduction of the ambient air concentration of sulphur dioxide and lead are 40 to 70 per cent for SO_2 or 65 per cent for lead.

However, these improvements must not obscure the fact that the concentration of other air pollutants, such as especially nitrogen dioxide, has still been rising in the last years.

Clean Air Plans

For all these reasons, new measures for reducing air pollution have been introduced in the Federal Repbulic of Germany by federal law. This applies particularly to the establishment of emission declarations, emission inventories and the implementation of clean air plans. The emission inventory states type, quantity, spatial and temporal discharge of the air pollutants and the emission characteristics for the various categories of emitters:

- industry (including power plants),
- small trade and domestic firing installations,
- transport, particularly motor cars.

The various sources are broken down according to point, area and line sources.

The results of a systematic assessment and analysis of emission data are used in tackling the following problems:

- assessment of spatial and temporal dispersion of specific pollutant components.

  So - e.g. - the emission inventory provides a survey of the contribution of individual emitters or groups of emitters to the emission of specific pollutant components.

- determination of air quality by means of mathematical dispersion models.

  The emission inventory is a necessary prerequisite for the establishment of diffusion models which may be used to determine the dispersion of pollutants in the atmosphere.

The more precise the input data, i.e. the emission inventory, the more realistic the forecasts obtained from the model used.

- introduction of air pollution control measures

  On the basis of a thorough analysis of the emission data recorded in the emission inventory, those emitters or groups of emitters may be determined from the pollutant concentrations derived from the model calculations where emission reduction methods will yield the most lasting improvements.

It is the objective of the measures to be taken within the framework of the clean air plan to ensure compliance with the ambient air quality standards for all pollutants occurring in any part of the exposed area or reduce pollutant concentrations to distinctly below these figures.

In the choice of active measures emphasis is therefore placed on a reduction of emissions:

- compliance with the state of the art with regard to emission reduction, but in special cases also gas cleaning techniques going beyond the state of the art,
- switching to lower pollution raw materials and fuels,
- introduction of new, lower pollution technologies, and
- improvement of high emission facilities.

Emissions and emissions reductions are given in table 2, the data are taken from an air quality maintenance plan for the Cologne region.

The secondary measure provided is the improvement of the emission conditions, mainly by constructing higher stacks, in order to improve pollutant dispersion if other measures cannot be taken or do not lead to a complete solution of the problems in question.

New instruments

The Federal Government adopted several legal measures to facilitate and harmonize the establishment of clean air plans. An ordinance on the emission declaration stipulates that the operators of specific types of facilities have to submit detailed information to the responsible authorities on the emission released from the plant in the previous year. The declarations are mainly prescribed for heavily polluted areas. For several types of facilities, however, emission declarations have also to be submitted if they are situated outside the polluted areas. This applies to large emitters, such as power plants reaching 4 Terawatt and more, facilities for the production of pig iron, including burden preparation, and mineral oil refineries with a throughput of more than 2.5 million metric tons of crude oil per year.

In addition, the Federal Government consented to an ordinance on the establishment of emission inventories. In this ordinance procedures are laid down which are to be applied in the assessment of the emissions from the various types of facilities that need not submit an emission declaration, i.e. above all the emissions from space heating systems, dry cleaners, fuel depots and motor vehicles. The emissions are predominantly to be given for an area of 1 km^2 and per year. For calculating the emissions, uniform emission factors are specified. In particular the following air pollutants are to be recorded in the emissions inventory:

- particulate matter
- fine particulate matter (diameter less than 10 µm)
- lead and lead compounds
- sulphur dioxide
- nitrogen oxides
- carbon monoxide
- gaseous organic compounds
- chlorine and gaseous inorganic chlorine compounds
- fluorine and gaseous inorganic fluorine compounds.

In addition, all substances are to be included in the inventory which have been given in the emission declarations. The inventory has to be updated after five years.

The Federal Government also provided uniform instructions on the details of the dispersion calculation - an essential component of any clean air scheme - in an administrative regulation. A so-called Gauss' plume model has to be used for which all required framework conditions, such as dispersion parameters, stack height above immission level, categories of dispersion, calculation of wind patterns have been laid down. The results of work done within the framework of the pilot study on Air Pollution Assessment Methodology and Modelling have already been put into practice here.

In addition, the technical details of air pollutant monitoring were standardized in administrative regulations. Especially the following air pollutants are to be measured continuously in polluted areas:

- particulate matter,
- sulphur dioxide,
- nitrogen dioxide,
- carbon monoxide
- gaseous organic compounds (excluding methane).

In the polluted areas, the monitoring stations are to be installed at a distance of about 4 km from each other. In addition to the concentration of air pollutants, the relevant meteorological dispersion parameters are to be determined.

The Federal Republic of Germany has launched the second stage of clean air policy. At the initial stage it was striven almost exclusively for the reduction of emissions through technological measures. At the second stage further instruments are used in addition, such as emission declarations, emissions inventories, dispersion calculations, emission and air quality predictions, air pollutant monitoring, establishment of clean air plans etc. The Government of the Federal Republic of Germany will continue further development of these instruments and endeavour to incorporate overall ecological considerations into measures of air pollution control.

Table 1 (I): Particulate Matter

Emissions

1965 about 2.16 million metric tons

1970 about 1 million metric tons

1975 about 0.56 million metric tons

1980 about 0.47 million metric tons (estimate)

Cause of emission reduction:

The Technical Instructions Air ("TA Luft") and further development of the state of technology

Immissions

1. Dust fall from 1970 - 1975 — Decrease by

Bochum	50 per cent
Dortmund	40 per cent
Lünen	50 per cent
Saarbrücken	60 per cent
Völklingen	70 per cent

2. Suspended particulate matter from 1970 - 1975

Duisburg-Hamborn	40 per cent
Gelsenkirchen	30 per cent
Mannheim	30 per cent
Essen-Karnap	35 per cent
Wiesbaden-Süd	30 per cent

Cause of immission reductions:

Emission reduction due to the implementation of the Technical Instructions Air ("TA Luft"). The improvements thus achieved contribute in particular to the reduction of dust fall.

Table 1 (II): Sulphur Dioxide

Emissions

1965 about 4 million metric tons

1970 about 4.3 million metric tons

1975 about 3.6 million metric tons

1980 about 4 million metric tons (estimate)

Cause of emission reduction:

Requirements of the Technical Instructions Air and limitation of sulphur content in light fuel oil (0.3 %).

Cause of increase from 1975 to 1980:
Increasing energy consumption

Emissions

From 1970 to 1975 decrease by 65 per cent

Cause of emission reduction:

Lead in Petrol Act, limitation of lead content to 0.15 g per l of petrol

Immissions

From 1964 to 1975:	Decrease by
Dortmund	40 per cent
Duisburg	20 per cent
Essen	65 per cent
Gelsenkirchen	40 per cent
München	70 per cent

From 1970 to 1975:	
Berlin-Steglitz	60 per cent
Castrop-Rauxel	40 per cent

Cause of immission reduction:

Requirements of the Technical Instructions Air and switching from coal to light fuel oil or natural gas in domestic firing installations

Lead

Immissions

From 1975 to 1976	Decrease by
Frankfurt (city)	70 per cent
München, Nürnberg, Würzburg, Regensburg	about 50 per cent

Table 2: Measures in the Air Quality Maintenance Plan Cologne

Substance	Emission* [1973]	Emission reduction up to [1976]	[1981]
	t/a	t/a	t/a
Inorganic gases	297 627	22 058	59 456
Sulfurdioxide	147 500	5 715	8 615
Nitrous oxides	75 761	210	1 073
Carbonmonoxide	68 554	14 000	45 743
Ammonia	2 472	601	1 038
Hydrogen Chloride	1 331	403	831
Chlorine	862	152	248
Hydrogen sulfide	349	191,5	201,9
Carbondisulfide	260	113	113
Hydrogen fluoric acid	117	70	70
Other inorganic gases	ca. 2 000	602,5	1 523,1
Organic gases and vapours	84 117	37 091	54 143
Ethene (Ethylene)	17 302	5 208	5 688
Aromates	9 413	1 614	2 765
Halogen-Hydrocarbons	5 724	329	536
Alcoholes	5 559	736	1 736
Dimethylformamid	4 250	2	1 522
Ester	2 406	167	248
Vinylchloride	3 700	1 035	2 340
Cetones	1 245	590	591
Aldehydes	725	6	48
Phenoles	318	142	162
Other hydrocarbons	35 841	27 262	38 507

* only emissions from industrial sources

ANNEX

BACKGROUND PAPERS TO RICHARD DAMS'

OVERVIEW OF AIR QUALITY

MANAGEMENT SYSTEMS IN PARTICIPATING COUNTRIES

BELGIUM

AN OVERVIEW OF THE
NATIONAL AIR QUALITY MANAGEMENT SYSTEM

A. LEGISLATION

The first legislation related to environmental problems with respect to the Belgium territory was the law concerning dangerous, unhealthy and incommodious establishments. It was first introduced in 1791 giving wide competences to local authorities. Its actual form was approved in 1946. This law imposes a lot of conditions to be fulfilled before an establishment is authorised to be installed and to operate. In practice it is the legal basis that permits communal or provincial authorities to impose specific individual exploitation conditions in order to preserve the quality of the environment.

A second important step and the real start of the development of legislation in relation to air pollution was the law of December 28th, 1964.

This outline law defines air pollution as "all type of emissions in the air either in gaseous, liquid or solid form, which could endanger human health or be nocive to animals and plants or damage the environment" and has two main objectives:

1. <u>To attribute large competences to the executive authority</u>

   By attributing to the King large competences in the field of air quality protection, it allows Him by means of royal decrees:

   - to forbid certain well defined types of air pollution;
   - to restrict and even forbid the use of apparatus or installations which could cause air pollution;
   - to impose regulations concerning the use of apparatus or installations to prevent or reduce air pollution.

Furthermore, it allows Him to impose special obligations in relation to the training of professionals in charge of the installation and control of air pollution abatement equipment.

2. Harmonisation and coordination in the field of air pollution

This outline law also determines precisely which departments are in charge of the royal decrees. In practice it is a joint responsibility of the Minister of Public Health and Environment and of the Minister to whoms competence the origin of the pollution problem belongs. In certain cases, the Minister of Public Health and Environment alone can propose necessary regulations.

The Minister of Public Healthand Environment is also responsible for the coordination of actions taken by all authorities involved in air pollution. He coordinates the execution of sampling and analysis, the application of research results, and public information with respect to environmental problems.

As an execution of this outline law the following royal decrees have been issued:

The Royal decree of July 26th 1971

defining 5 zones of special protection from pollution. It includes a number of special regulations in order to protect the air quality in the areas of Ghent, Brussels, Antwerp, Liège and Charleroi. In these zones combustion of peat, lignite, non smokeless coal and waste is forbidden for house heating purposes.

Also, the sulphur content of all type of fuels either solid, or liquid may not exceed 1 %. Finally, burning rubbish in open air is also forbidden except the one resulting from gardening and agriculture.

The Royal decree of August 8th 1975

concerning the abatement of air pollution by sulphuroxides and particulates emanating from industrial combustion processes and thermal power plants. It limits the level of the emissions of sulphuroxides and particulates from power plants and imposes special regulations in relation to stack height. Emissions from other industrial combustion processes are also regulated by this decree. It also includes special regulations for those installations located within the zones of special protection. In practice these installations are forced to use low sulphur content fuel or to desulphurize fumes. The sulphur content of all fuels in use is also regulated.

The Royal decree of January 6th 1978

concerning emissions due to space heating. This decree states that all installations for space heating have to be controlled every year by a qualified technician and that furthermore a yearly chimney cleaning has to be performed. New installations must also be controlled before use.

The Royal decree of November 8th 1971

limits the CO content in the exhaust gases of motor-vehicles to 4,5 % when running idle.

The Royal decree of March 29th 1977

limits the lead content in gasoline to 0.45 g/liter.

The Royal decree of May 31st 1978

is a special regulation to a local lead pollution problem and states that in Hoboken, where a large lead smelter is operating, the yearly average lead content in the ambient air must be limited to 2 $\mu g/m^3$ from June 1st 1983 on.

Finally, a Royal decree has been issued imposing special regulations to an establishment, origin of a local fluoride problem.

B. ENVIRONMENTAL MONTITORNING

The Control measurements in relation with air pollution are subdivided into:

- air quality measurements;
- determination of the degree of contamination of vegetation and soil.

1. AIR QUALITY NETWORKS

Besides several smaller, temporary measuring systems, which control local pollution problems, four major networks are in routine operation. The exploitation of the networks is under supervision of the Ministry of Public Health.

The Sulphur-Smoke Network

is the first air pollution measuring system in Belgium and has been installed in 1967. The 24-hours average concentrations of sulphurdioxide and small particulates in the air are used as pollution indicators. The system relies on the OECD recommendation of 1964 in order to make a comparison with measurements in the United Kingdom and France possible. The Sulphur-Smoke-net consists of 230 stations. Sampling and analysis is done in collaboration with local laboratories.

The Automatic Network

is under construction since 1977. The network consists of:

- 51 measuring stations (Remote Terminal Unit: RTU) in the 5 regions of special protection mentioned above and 17 RTU's in a national network to provide general and background information;
- the 51 RTU's of the regional networks are connected to 5 "Regional Data Reduction Centers" (RDRC);
- the 5 RDRC's and the 17 RTU's of the national network are coordinated by the "National Data Processing Center" (NDPC).

The national network has the same configuration as the one in the Netherlands. In all stations, SO_2 is measured with a 30 minutes averaging time. Depending on local situations determinations of NO_x, CO, O_3, small aerosols, hydrocarbons and meteorological parameters are performed.

Through the Belgian Heavy Metal Network (15 stations) the 24-hours average concentration of 9 heavy metals in ambient aerosols is monitored since 1972. Twelve sampling units are located in industrial and residential areas, the others being a rural, a coastal and a background station.

Deposit gauges

A network containing about 350 deposit gauges is in operation since 1966 in a heavily polluted area. In 1978 the number of units has been reduced, focusing some problem areas. Sampling time is 28 days, the acidity of the collected water and several cations and anions are determinded in routine.

2. DETERMINATION OF VEGETATION AND SOIL CONTAMINATION

In the framework of the National R-D Program on Environment and in collaboration with the Ministry of Agriculture the degree of heavy metal and fluor contamination of soil and plants is determined in routine in a number of test-stations in the industrial areas of Ghent and Liège.

In addition, severals special campaigns in relation to local pollution problems have been carried out.

C. EMISSIONS INVENTORY SYSTEMS

In Belgium the efforts in relation to emissions inventory are still being carried out within the framework of the National R-D Program on Environment. This program started in 1975 and will, in its present form, end in 1981. One of the major objectives of this program was to develop appropriate methods for inventorying industrial emissions, space heating emissions and mobile source emissions.

At this time, the method development phase is almost finished and a systematic registration of the emissions of the three categories of sources is undertaken. This operation is fully sponsored by the Government through the Ministry for Science Policy. The teams in charge of this belong either to universities or state laboratories.

As far as industrial emissions are concerned, an individual approach in two steps has been adopted. In a first step, industries are asked to furnish some general, mainly qualitative, information concerning installations and apparatus, sources, raw materials used and pollutants emitted. This "preliminary registration" covers all establishments of more than 50 people and all other establishments that may cause air pollution because of thenature of its activities. In a second phase a more detailed inventory is elaborated. This inventory contains on one hand specific permanent information and on the other hand variable information related to the level of activity. This variable information is collected on a monthly basis. Such a complete inventory is actually finalized in the areas of Ghent, Liège and Tessenderlo. At this moment in total 40 persons are in charge of this inventory. The whole system is very similar to those used in the Netherlands and in the Federal Republic of Germany. An annual updating of the data is envisaged.

As to mobile source emissions, a collective approach is in use. The method is completely new and was developed within the National Program. In a first step, the traffic in the area under investigation is divided into a number of categories, whereafter the medium car speed for each category is determined by means of a number of test runs. The traffic density is then determined as a function of car speed and the emissions can be calculated from traffic density. This rather sophisticated method has been applied in the areas of Ghent, Liège, Brussels and Tessenderlo.

For registration of the space heating emissions a collective approach is used. The whole system is based on statistical information such as population density, and quantities and type of fuel used. Emission factors are then applied with respect to burner type, construction property, heating capacity, ... Finally, a relation between emissions and outdoor temperature is established giving the emissions for each pollutant. This method has also been applied to the areas of Ghent, Liège, Brussels and Tessenderlo.

D. MODELING

In the National R-D Program on Environment special attention is paid to air pollution modeling and either gaussian and non-gaussian models are developed.

Disposing of a complete emissions inventory for SO_2 for the area of Ghent and of a considerable amount of meteorological data a calibration and validation of these models is actually performed using the ambient SO_2 concentrations measured by the automatic and sulphur-smoke networks.

Studies of air pollution dispersion under calm wind situations or over complex terrains are also undertaken.

CANADA

AN OVERVIEW OF THE NATIONAL AIR QUALITY MANAGEMENT SYSTEM

Canada's Clean Air Act was officially proclaimed on November 1, 1971. This Act provides the basis for the Federal Government's air pollution control activities and has three main elements. First, it reflects recognition by the federal government of the primary jurisdictional authority of provincial governments to control air pollution by providing for various ways and means to complement and supplement provincial programs. The second major element of the Act is that it provides federal authority to regulate in those areas where federal jurisdiction is involved. These areas include the control of pollutants which are hazardous to health, the control of pollutants from federal facilities, and the composition of fuels. The delineation of a federal leadership role is the third major element of the Act, enabling the federal government to promote uniformity across Canada and prevent pollution havens.

Because air pollution control in Canada is a shared jurisdiction, a Federal-Provincial Committee on Air Pollution including all ten provinces has been constituted as the principal formal mechanism for obtaining Federal-Provincial co-operation and to ensure participation of all who wish to participate in specific projects. This Federal-Provincial Committee is a working committee of senior officials in air pollution control at the federal and provincial levels of government.

Air Quality Objectives

The Clean Air Act authorizes the development of ambient air quality objectives based on a three level approach. These objectives are prescribed for "desirable", "acceptable" and "tolerable" ranges for each pollutant. The maximum desirable levels define the long-term goal for air quality and provide a basis for an anti-degradation policy for the unpolluted part

of the country. They will also provide an incentive for continuing development of control technology. The maximum acceptable levels are intended to provide adequate protection against effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being. The maximum tolerable levels denote concentrations of air contaminants that require abatement without delay to avoid a further deterioration of conditions to an air quality that endangers the Canadian lifestyle, or, ultimately to an air quality which poses a substantial threat to public health. Objectives at all three levels have been promulgated for sulphur dioxide, total suspended particulate matter, carbon monoxide, (ozone) and nitrogen dioxide. In 1976 objectives at the desirable and acceptable levels were proposed for hydrogen fluoride and hydrogen sulphide. Existing and proposed air quality objectives are shown in Table I.

Air Quality Monitoring

Another project of the Federal-Provincial Committee on Air Pollution is the National Air Pollution Surveillance Network. This Network is a Federal-Provincial co-operative activity. The provincial agencies, for the most part, operate monitoring stations in the Network and report the data to the Federal Government. The Federal Government's role varies from technical advice to the supplying on loan of the instrumentation and the instrument maintenance and calibration. In some cases, the Federal Government may operate the equipment as well. The Network is designed to monitor all locally significant air pollution parameters in all significant centres of population. The Network consists of 560 instruments in 158 stations located in 54 cities, and includes monitoring for soiling index, suspended particulates, lead, dustfall, sulphation rate, sulphur dioxide, hydrocarbons, carbon monoxide, nitrogen dioxide and ozone.

Stationary Sources

The Federal Department of Environment has a program of developing emission guidelines for specific industry sectors. The guidelines, while not federally enforceable, are viewed as the federal requirements for new sources aimed at reducing and/or avoiding further environmental degradation. The guidelines also serve as goals for existing sources. The government's philosophy on pollution control, while based on containment at source also recognizes that local conditions in specific areas of the country may require more stringent control. Guidelines have been published for the following industry sectors:

1. Cement Industry (1974)
2. Asphalt Paving Industry (1975)
3. Metallurgical Coke Manufacturing Industry (1975)
4. Arctic Mining Industry (1976)
5. Wood Pulping Industry
6. Packaged Incinerators

In addition guidelines are presently being developed for the following sectors:

1. Iron and Steel
2. Ferrous Foundries
3. Natural Gas Processing Plants
4. Petroleum Refineries
5. Thermal Power Plants
6. Non-Ferrous Smelters
7. Chemical Fertilizers
8. Petro-chemicals and Resins.

Environment Canada also develops national emission regulations for those industries which have emissions that are considered to constitute a significant danger to human health. Such regulations are enforceable by the federal government.

The following regulations are in force:

1. Lead emissions from Secondary Lead Smelters
2. Mercury Emissions from Chlor-Alkali Plants
3. Asbestos Emissions from Mining and Milling Operations
4. Vinyl Chloride Emissions from Vinyl Chloride and Polyvinyl Chloride Plants.

Development continues on regulations to control arsenic emissions from gold roasting operations and from non-ferrous smelters. Consideration is being given to the development of regulations controlling emissions of mercury and lead from non-ferrous smelters and mercury from iron ore processing.

Mobile Sources

The automobile is the most significant source of air pollution in this category. Emission limits which have been in effect since model year 1975 and will remain unchanged until model year 1981 are:

Carbon monoxide:	25.0 grams per vehicle mile
Hydrocarbons :	2.0 grams per vehicle mile
Nitrogen oxides:	3.1 grams per vehicle mile

Fuel Regulations

Lead-free Gasoline Regulations

These regulations restrict the concentrations of elemental lead and phosphorus to a maximum of 0.06 grams per Imperial gallon and 0.005 grams per Imperial gallon respectively.

Leaded Gasoline Regulations

The maximum concentration of lead is restricted to 3.5 grams per Imperial gallon. The regulations also require the submission, commencing October 1, 1974, of information on the amount of lead additive being used by the refining industry and importers and on average lead concentrations in leaded grades of gasoline, during each quarter. This information, together with data on the increased use of lead-free gasoline, is intended to enable the government to ascertain whether the overall objective of reducing lead emissions from automobiles is being achieved. Consideration is now being given to phased further reductions in the amound of lead permitted.

Fuels Information Regulations

These regulations apply to fuels in liquid form that originate from crude oils, coal or bituminous sands and require every person who produces or imports more than 400 cubic metres of fuel to report the indicated information.

Canada is continuing to examine fuel composition and may regulate the use of fuel additives, in addition to lead, and restrict sulphur content in the future. Two major urban centres, Montreal and Toronto, are restricting the suphur content of fuel oils.

Emission Inventories

One of the first actions taken by the Federal Government after passage of the Clean Air Act was the compilation of a Nationwide Emissions Inventory for Canada. The inventory provided an overview for 1970 of air pollution problems for four of the five major contaminants for which National Air Quali-

ty Objectives have been established, sulphur dioxide, particulate matter, carbon monoxide and nitrogen oxides, and includes hydrocarbons as well. The inventory was then revised and updated to provide a similar overview of Nationwide emissions for 1972, 1974 and recently for 1976 for which preliminary data are shown on the attached Table 2. As the inventory is regularly updated, it will continue to provide an additional basis for assessing the results of federal and provincial control programs.

Abatement of Air Pollution

Generally, based upon average annual concentrations measured at National Air Pollution Surveillance Network stations, there was a decreasing trend for most contaminants during the 1970 - 1977 period, the exception being nitrogen dioxide.

The average annual concentration for sulphur dioxide decreased approximately 70 % from 1970 to 1977. The extent of this decrease is exemplified by the fact that in 1970 ten of eleven stations (approximately 90 %) exceeded the maximum acceptable annual level of National Ambient Air Quality Objectives, compared with three of 59 stations (approximately 5 %) exceeding this same level in 1977.

The average of the annual geometric means for suspended particulates decreased approximately 25 % from 1970 to 1977. Approximately 25 % of the stations exceeded the maximum acceptable annual level in 1977.

From 1974 to 1977, the percentage of stations exceeding the maximum tolerable 24-hour level remained relatively constant at approximately 8 %, while over 80 % of the stations exceeded the maximum acceptable 24-hour level.

The average of the annual geometric means for lead decreased by 40 % from 1970 to 1977. Annual lead levels have consistently decreased significantly since 1973. Similarly the national average for 24-hour lead concentrations also has decreased since 1974. Carbon monoxide annual averages decreased by approximately 40 % from 1973 to 1977. Since 1975 there has been little change in the national average.

Similar to the general trend observed for the aforementioned contaminants, the annual mean for nitrogen dioxide actually decreased slightly from 1973 to 1976. In 1977, however, a substantial increase in the annual average resulted in an overall increase for the 1977 - 1977 period. All stations measuring nitrogen dioxide met the maximum acceptable annual levels from 1973 to 1976. In 1977, one station exceeded the maximum acceptable annual level. In both 1974 and 1977, approximately 15 % of the stations had 24-hour maximum values in excess of the maximum acceptable 24-hour level. By comparison, 15 % of the stations exceeded the maximum acceptable 1-hour level in 1977, as opposed to 25 % in 1974.

All ten provinces of Canada now have legislation respecting air pollution control, ranging from the very comprehensive program of Ontario, the most heavily industrialized province, to the quite modest program of Prince Edward Island, a small agriculturally oriented province. The development of the provincial agencies is aided by a federal policy of using provincial delivery systems to implement federal regulations wherever possible.

The wide range of co-operative programs assist the provincial agencies to measure the effectiveness of their programs, and permit the federal government to have a continuing indication of the state of air quality generally across the country.

Table 1

CANADA
AMBIENT AIR QUALITY OBJECTIVES*
(as of January, 1980)

Contaminant		Maximum DESIRABLE Level		Maximum ACCEPTABLE Level		Maximum TOLERABLE Level	
Sulphur Dioxide	(Annual)	30 $\mu g/m^3$	(.01 ppm)	60 $\mu g/m^3$	(.02 ppm)	----	
	(24 hrs.)	150 $\mu g/m^3$	(0.06 ppm)	300 $\mu g/m^3$	(.11 ppm)	800 $\mu g/m^3$	(.31 ppm)
	(1 hour)	450 $\mu g/m^3$	(.17 ppm)	900 $\mu g/m^3$	(.34 ppm)	----	
Suspended Particulate Matter	(Annual)	60 $\mu g/m^3$		70 $\mu g/m^3$		----	
	(24 hrs.)	--------		120 $\mu g/m^3$		400 $\mu g/m^3$	
Carbon Monoxide	(8 hrs.)	6 mg/m^3	(5 ppm)	15 mg/m^3	(13 ppm)	20 mg/m^3	(17 ppm)
	(1 hour)	15 mg/m^3	(13 ppm)	35 mg/m^3	(31 ppm)	----	
Oxidants (Ozone)	(Annual)	--------		30 $\mu g/m^3$	(.015 ppm)	----	
	(24 hrs.)	30 $\mu g/m^3$	(0.015 ppm)	50 $\mu g/m^3$	(.025 ppm)	----	
	(1 hour)	100 $\mu g/m^3$	(.05 ppm)	160 $\mu g/m^3$	(.08 ppm)	300 $\mu g/m^3$	(.15 ppm)
Nitrogen Dioxide	(Annual)	60 $\mu g/m^3$	(.03 ppm)	100 $\mu g/m^3$	(.05 ppm)	----	
	(24 hrs.)	--------		200 $\mu g/m^3$	(.11 ppm)	300 $\mu g/m^3$	(.16 ppm)
	(1 hour)	--------		400 $\mu g/m^3$	(.21 ppm)	1000 $\mu g/m^3$	(.53 ppm)
Hydrogen** Fluoride	(70 days)	--------		.20 $\mu g/m^3$	(0.2 ppb)	----	
	(30 days)	--------		.35 $\mu g/m^3$	(0.4 ppb)	----	
	(7 days)	.20 $\mu g/m^3$	(0.2 ppb)	.55 $\mu g/m^3$	(0.7 ppb)	----	
	(24 hrs.)	.40 $\mu g/m^3$	(0.5 ppb)	.85 $\mu g/m^3$	(1.0 ppb)	----	
Hydrogen** Sulphide	(24 hrs.)	--------		5 $\mu g/m^3$	(3.6 ppb)	----	
	(1 hour)	1 $\mu g/m^3$	(0.7 ppb)	15 $\mu g/m^3$	(10.8 ppb)	----	

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* Conditions of 25°C (77°C) and 1013.2 mb (760 mmHg) are used as basis for conversion from $\mu g/m^3$ to ppm, ppb.

** Proposed

Air Pollution Control Directorate February 21, 1980

Table 2: Nationwide Emissions of Air Contaminants, 1976

CATEGORY	EMISSIONS (ton/year) Particulate Matter	Sulphur Oxides*	Nitrogen Oxides**	Hydro-carbons	Carbon Monoxide
Industrial processes	1,192,074	3,756,957	126,613	215,791	1,003,279
Fuel Combustion/ Stationary Sources	197,059	1,435,675	547,583	137,145	267,469
Transportation	73,037	77,923	1,006,965	1,012,424	8,605,346
Solid waste incineration	34,175	3,245	5,094	25,966	314,941
Miscellaneous	682,231	-	147,020	1,234,026	5,071,494
TOTAL	2,178,576	5,273,800	1,833,275	2,625,352	15,262,529

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* Expressed as SO_2

** Expressed as NO_2

Total pollution load is 27,173,532 tonnes

FEDERAL REPUBLIC OF GERMANY

AN OVERVIEW OF THE NATIONAL AIR QUALITY MANAGEMENT SYSTEM

1. INTRODUCTION

The environmental protection policy of the Government of the Federal Republic of Germany in general, and air quality management in particular, is basing on the three following principles:

1) Precaution

This principle requires that the natural ressources be protected and rationally used - thus going beyond a mere protection of the environment from imminent dangers and the elimination of damages to the ecosystems. According to the principle of precaution air pollution shall as far as possible not occur. One of the main means of precaution is the taking into account of the technological progress in a way that the best available control technology has to be applied in the installation and operation of plants which are suspected to be harmful to the environment. This is defined as the state of the development of advanced processes, facilities and operations for emission reduction.

2) Polluter-Pays-Principle

The costs for avoidance, elimination or compensation of environmental pollution have to be allocated to the polluter. Polluter is who directly or indirectly pollutes the environment.

3) Cooperation

Environment policy can yield solid results only if the Federation, the Länder and the local authorities closely cooperate with all social forces and citizens.

2. RESPONSIBILITIES; CITIZENS' PARTICIPATION

The overall responsibility for the protection of air quality in the Federal Republic of Germany is with the Federal Minister of the Interior. In order to provide scientific advice and assistance to the ministry the Umweltbundesamt (Federal Enivronmental Agency) was established in 1974. The agency in particular assists the Government in preparing ordinances and administrative orders and in research and development of the fundamentals for appropriate measures for protecting air quality. In addition, the agency is charged with the information of the public and the creation and furthering of public awareness for environmental matters. In the process of preparation of ordinances and administrative orders the above mentioned principle of co-operation requires to hold a hearing which shall include all parties concerned in the decision making process. These parties are: representatives of science and economics, the relevant traffic authorities as well as the Länder authorities who are responsible for the control of air quality.

An important part of the preparative work for legislative provisions is done by the Kommission Reinhaltung der Luft (Commission on Air Quality) of the Association of German Engineers. This commission was established upon recommendation of the Government of the Federal Republic of Germany. On a strictly voluntary basis and together with the Deutsches Institut für Normung (German Standards Institute), it works out technical guidelines for the control of air quality which quite often are referred to in the pertinent legislation.

The enforcement of environmental protection legislation has to be done by the various Länder. During the enforcement procedure too the participation of the public is provided for: e.g. all documents which have to be submitted by an applicant for a licence for the construction of a technical/industrial plant have to be rendered accessible for the public. This enables every citizen to protest against the licence for a certain plant.

At present the Government examines the question of improving the citizens' participation by admitting interest groups to go to law.

3. LEGISLATIVE REGULATIONS

The legis-lative basis for air quality control in the Federal Republic of Germany are the Bundes-Immisionsschutzgesetz (BImSchG) as of January 18, 1974: Law for the Prevention of Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration and Similar Phenomena and the pertinent legislative orders together with the TA Luft (Technical Instruction Air) as of August 28, 1974.

The latter is an administrative order committing the administrative enforcement acitivities of the licensing authorities to the BImSchG.

The main goal of the BImSchG and, generally speaking, of the longer-term air quality control policy is to reduce the total of air pollution by pollutants and noise.

With regard to maintaining and improving the quality of the air the BImSchG includes the following strategies - working independently from each other:

Control of Immissions (Air Quality Control)

By setting air quality standards it shall be avoided that independent from the already existing emission situation tolerable air quality standards are exceeded by the establishment of new emitters or the extension of existing emitters.

Control of Emissions

According to the principle of precaution emissions have to be controlled in a way that the application of all possible emission reduction measures taking into account the best available control technology is assured in every single case.

These strategies ar implemented by plant related and product related measures.

Plant Related Measures

Industrial and trade facilities potentially harmful to the environment to a particular extent may not operate without a licence. The fourth ordinance under the BImSchG lists about 100 groups of plants subject to licensing. The foundation of the licensing procedure is put down in the ninth ordinance under the BImSchG.

With regard to securing a uniform administrative practice in interpreting and applying the BImSchG the Technische Anleitung zur Reinhaltung der Luft, TA Luft (Technical Instruction Air) has been enacted in 1974. It gives i.a. the following direct instructions for the licensing procedure:

a) air quality standards for ten of the most important air pollutants

b) emission standards according to the best available control technology for 170 air pollutants and for more than 40 plants

c) definition of the technological processes and instruments which have to be used for the determination (e.g. measurement) and assessment of air quality and emissions as well as for the dispersion of the emissions.

The plant related measures shall be completed by an ordinance in preparation on accidents and operation failures. This ordinance (Störfallverordnung) shall prevent hazardous effects which may occur as a consequence of the uncontrolled emission of certain substances into the air due to operation failures.

In addition, requirements for plants which are not subject to a licence and automobiles can be set to protect the environment from harmful emissions.

Measures Related to Certain Regions

These measures aim at the maintenance of a certain air quality in low polluted areas and at an improvement of the air quality in heavily polluted areas.

The following measures apply to the latter:

a) declaration of heavily polluted areas (by the responsible Länder authorities)

b) emission records (by the operator/owner of the plants)

c) establishment of emission inventories (by the responsible Länder authorities)

d) establishment of clean air plans (e.g. already existing: Clean Air Plan Rheinschiene Süd, or Ruhrgebiet West in Northrhine-Westfalia).

The above measures, in particular the technical measures for heavily polluted areas, are complemented by general and regional planning means in all areas (e.g. authorization for the declaration of protected areas; siting plans for large-scale industrial plants and power plant).

Product Related Measures

The properties of materials and products are determined on the basis of the BImSchG or other laws. The relevant regulations are made especially for the manufacturers of the materials and products: e.g. the Benzinbleigesetz (Lead in Petrol Law) as of August 1971 - providing for a reduction of the lead content in petrol to 0.15 g/l effective 1976 - and the ordinance about the sulphur content in light fuel oil and diesel oil (third ordinance under the BImSchG) - providing for a reduction of the sulphur content to 0.3 % S/weight effective January 1979.

For the time being the Government of the Federal Republic of Germany prepares a further improvement of the legislative provisions aiming at an alleviation of heavily polluted areas, at a furthering of their economic development as well as at the maintenance of the quality of the air in low polluted areas.

4. OFFENCES AGAINST ENVIRONMENTAL LAWS

In the Federal Republic of Germany a difference is made between illegal and criminal acts.

Most of the Länder have enacted inventories of financial penalties and admonitions regulating illegal acts. Criminal offences against the environment are regulated by the penal code.

AIR QUALITY MANAGEMENT SYSTEM/THE NETHERLANDS

In The Netherlands exists the structure for an SO_2-Air Quality Management System ("SO_2-beleidskaderplan"). Although this is not a real Air Quality Management System as described in report nr. 71 of the NATO/CCMS project, it contains several elements of the guidelines.

A description will be given following the building blocks of the above mentioned report:

- the assessment of present ambient air quality, emissions and related factors;
- the comparison with existing standards and criteria;
- projection of future emissions and ambient air quality;
- the development and implementation of a control strategy.

1. ASSESSMENT

A detailed air pollution emission inventory system exists in The Netherlands as described in NATO/CCMS-report 104 appendix D. Since the beginning of 1974 an inventory of pollutant emissions has been compiled. The estimate for the whole country for the year 1977 is an emission of SO_2 of approximately 470×10^6 kg.

Using several emission scenarios for the possible development of energy needs, estimations are made for the total amount of SO_2 to be emitted in future years.

The existing ambient air quality is assessed using the data of the National Air Pollution Network which gives half yearly overviews of the development of the nation wide ambient air

quality pollution levels, including the main sources responsible for the short term higher pollution levels (episodes) and for the high (95 %) percentiles on a yearly basis. Seasonal and yearly overviews of isoline-maps and case-studies of a large number of air pollution episodes are available since 1976.

Additional data is available on:

- meteorological data: windspeed and winddirection and other parameters normally gathered at regular meteorological measurement stations;

- atmospheric chemistry data: oxidant concentrations; chemical analysis of rainfall in a national network (12 stations);

- actual transport determinations over longer distances of pollutant amounts.

2. THE EXISTING STANDARDS AND CRITERIA

In the Dutch plan the central objective is an emission ceiling of 500 x 10^6 kg SO_2/year. This ceiling value is based on:

- Observed effects of deposition of SO_2 and consecutive products in valuable areas within and outside The Netherlands.

- Objectives for an SO_2-air quality standard for the protection of human health:
  - 50-percentile of 75 µg SO_2/m^3
  - 95-percentile of 200 µg SO_2/m^3

  } frequency distribution of 24 hours averages for one year

with so-called emergency levels for short periods ranging from 900 $\mu g/m^3$ as half hours value to 500 $\mu g/m^3$ as 24-hours average

For the protection of nature conservation areas:

- 50-percentile of 30 $\mu g\ SO_2/m^3$
- 98-percentile of 100 $\mu g\ SO_2/m^3$

These objectives for the ambient air quality will serve as a basis for standards that will be set in the near future.

The objectives for the standards are connected with the emission ceiling by means of a model which allows the calculation of yearly average SO_2-concentrations for the whole area of The Netherlands.

3. PROJECTION OF FUTURE EMISSIONS AND AMBIENT AIR QUALITY

The energy scenarios mentioned before would lead to an SO_2-emission for the whole of The Netherlands which would amount to 2-3 times the total emission for 1977 if no abatement techniques are used. An assessment of the impact of these emissions was made using the air quality model for The Netherlands.

It was estimated that yearly average SO_2-concentrations would accordingly increase between 120 and 150 % leading to local exceedance of the standards to be set.

4. CONTROL STRATEGY

Although the Dutch plan sofar only gives the structure and not the final contents of the control strategy plan that will be used, a large number of basic elements and alternative possibilities are mentioned.

Possible technologies that can be used in the future to reduce the emissions of SO_2 into the environment are discussed, also possible standards are mentioned: emission standards (instructions for design and operating standards), equipment and product standards that, together with proposed ambient air quality standards should protect the environment as a whole.

In the plan also an outline is given of the economic consequences of the management proposals and the possible financing of separate projects.

On the basis of the acutal developments the control strategy plans will be implemented for a 3-year period with the regular revisions.

5. FUTURE

The implementation of a first (complete) control strategy plan for SO_2 and a subsequent NO_X air quality management plan are expected to be published in 1981.

STATUS OF AIR QUALITY MANAGEMENT
UNITED STATES OF AMERICA

The United States endeavors to protect and enhance the quality of the Nation's air resources through the cooperative efforts of Federal, State, regional and local governments. The States and local governments retain primary responsibility for the prevention and control of air pollution at its source. The Federal government provides the leadership and financial assistance for the development of cooperative and effective air pollution control programs. These relationships and responsibilities are established by the Clean Air Act, enacted in 1963 and amended several times, most recently in 1977. The Act and the numerous court decisions which interpret the meaning of the Act form the legal basis for the Nation's effort to provide a clean air environment for its citizens.

The Environmental Protection Agency (EPA) ist the Federal body responsible for administering the Clean Air Act. It establishes national ambient air quality standards for a number of pollutants and assesses the States' plans to attain and maintain the standards. A State may establish more stringent ambient air quality standards. However, a State must, in its implementation plan, show how its emission limitations, its schedules for compliance and its enforcement procedures will enable the national ambient air quality standards to be met in a reasonable, timely and effective manner.

This approach, dictated by the Clean Air Act, rests on a system of air quality management. The heart of air quality management is the set of ambient air quality standards. The management takes place through the regulation of the amount, location and time of pollutant emissions. The practice of air quality

management requires a methodology to relate ambient air quality to emissions. This methodology is often an air quality simulation model. The triad - emissions and emission limitation, models, air quality and ambient air quality standards - represent the three broad and basic elements of air quality management as practiced in the United States.

The guiding principle in the United States is that emissions shall be controlled at the source. The States, therefore, have the final responsibility for this control under the Clean Air Act. Most of the costs of air pollution control occur in designing, constructing, installing and operating emission control devices. A significant part of the public funds devoted to air pollution control is spent studying, researching and documenting emission control procedures and archiving the status of control throughout the Nation. EPA plays a major role in these activities. Among the most significant of EPA's activities are programs to select feasible control procedures for existing sources and to develop emission (performance) standards which must be met by new sources in many categories of industrial activities.

The States also have the final responsibility to ascertain the quality of their air environment through a monitoring program. EPA provides technical guidance and financial support for monitoring activities. It certifies monitoring equipment and issues performance standards and statements of equivalency for monitoring procedures and equipment.

It specifies quality control procedures for all aspects of data collection to assure that the information used to assess the condition of the air environment is complete and reliable. In this respect it designates a number of monitoring sites in each State for most rigorous attention and quality control. These sites particularly identified, though operated by the States, are called National Air Monitoring Stations (NAMS). Data from

these stations constitute the key data used for analyses of the status of the Nation's air environment and for the determination of trends in air quality nationwide.

The EPA plays a central role in applying analytical techniques to relate air quality and emissions. EPA issues guidelines on air quality modeling, which attempt to reflect the state-of-the-art in the matter. These guidelines were issued only after a period for comment from the scientific community and the public. They are under continuous review. To insure that no scientific advance goes unrecognized or unheeded, EPA has entered into a unique cooperative agreement with the American Meteorological Society. The Society will provide scientific assistance in evaluating the technical aspects of air quality simulation models proposed for use by EPA.

There are important exceptions to the "pure" air quality management approach. The degree of emission control from individual automobiles (and a few other classes of mobile sources) is legislated by the Congress and enacted into law. This in a sense is incompatible with the air quality management approach. But it recognizes the great mobility of the automobile in the United States and the significant role it plays in the degradation of the air environment in major urban areas of the Nation.

The restrictions on intermittent control of air pollutants and on the use of tall stacks as a control mechanism are also inconsistent with a "pure" air quality mangement approach. The restrictions, however, are consistent with the guiding principle that the air environment should be protected by reduction of emissions. More fundamentally the position with respect to these two mechanisms is based on concern for the impact of emissions or their deleterious by-products at long distances from the source. Nevertheless, there are a few special situations where these mechanisms are applied.

In summary, the United States pursues its program for enhancing the air environment by air quality management procedures. The program requires close cooperation among the hierarchy of governmental bodies. Leadership and financial assistance emanates from the Federal level and the control of sources lies at the State and local level. A number of alterations to the air quality management approach are applied to contend with special circumstances.

LIST OF AUTHORS

- Richard Dams
  Institute Nuclear Sciences
  University of Gent
  Proeftuinstraat 86
  B-9000 Gent
  Belgium

- Hans Ludwig Dreißigacker
  Bundesministerium der Inneren Ref. UII8
  Graurheindorfer Str. 198
  D 5300 Bonn 7

- Herschel H. Slater
  U.S. EPA (MD-14)
  Research Triangle Park, NC 27711
  U.S.A.

- Herbert Meinl
  Dornier System GmbH
  Postfach 1360
  D-7990 Friedrichshafen

- Christa Morawa
  Umweltbundesamt
  Bismarckplatz 1
  D-1000 Berlin 33

- Fritz Surendorf
  Bundesministerium des Inneren Ref. UII8
  Graurheindorfer Str. 198
  D-5300 Bonn 7

LIST OF AUTHORS (Cont.)

- Joe Tikvart
  U.S. EPA (MD-14)
  Research Triangle Park, NC 27711
  U.S.A.

- Erich Weber
  Bundesministerium des Innern Ref. U II 8
  Graurheindorfer Str. 198
  D-5300 Bonn 7

- Martin L. Williams
  Warren Spring Laboratory
  Department of Industry
  Gunnels Wood Road
  STEVENAGE, Herts.
  England, U.K.